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The Great Quetta Earthquake.

Scarcely had India recovered from the effects of the Great Bihar Earthquake of 1934 when she was again visited by a calamity of much vaster dimensions though limited over a smaller area. The region to suffer this time is Baluchistan. The event occurred on May 31, in the early hours of the morning, when practically everybody was asleep indoors.

The full extent of the calamity is not yet accurately known, but there is very little doubt that it will rank as one of the major calamities that have befallen mankind. Baluchistan is a sparsely populated area, the average not exceeding seven per sq. mile. But during the British rule, the area has increased in importance owing to its being selected as a major base for military operations. Several important stations have grown up, the chief being Quetta. This is a large military cantonment and has a population which varies between 40,000 in winter to 70,000 in summer and this population is divided between the civil and military areas. It is further an important railway junction between Afghanistan and India,—the railway running from Sukkur in Sind to Bolan Pass via Quetta to Chaman on the Afghan frontier. The indigenous population consists of Baluchees, Pathans, and a large number of Hindus from the Punjab and Sind, and a large military population consisting chiefly of Europeans, and Indian Sepoys.

The time of occurrence of the earthquake was 3 A.M. on Friday. According to reports so far received, the intensity of the shock was so great that the civil station was completely laid flat with only foot-high walls standing. As most of the people were sleeping inside on account of a recent cold spell, nearly the whole of the population in the civil area was buried under the debris. The cantonment area was less damaged. According to the latest estimate 75% of the whole population of 35,000 in the civil area was killed instantly or buried under the debris of fallen houses. The newspaper reports describe the whole city as a vast burial ground. Round about Quetta the small towns and the villages also have suffered terribly. A small city, Mastung, is said to have been completely destroyed, and only one old woman, out of a population of 2000, is said to have escaped alive. The city of Khelat, the seat of a feudatory chief, the Khan of Khelat, has also been razed to the ground. Aerial reconnaissance shows that the villages in the plains around have been almost completely wiped out. The total casualties are now placed at nearly 60,000 dead of which 40,000 are recognised in government reports.

We may compare these figures with those of the Bihar earthquake where according to the official estimate the total casualties amounted to 7200 dead in Bihar and 4000 in Nepal. Thus the Quetta earthquake far surpasses the Bihar disaster in its intensity. The casualty was greater because the earthquake took place at the dead of night when everybody was sleeping indoors, while in Bihar it took place at 2. 15 P. M. when people were mostly outdoors.

The major earthquake on the 31st May was succeeded by after-shocks, one of which took place on Sunday at 2. 51 P.M. and reached almost catastrophic dimensions.

It is officially estimated that between 25,000 to 26,000 persons are dead at Quetta city alone, as a result of the earthquake. This figure has been estimated on the basis that out of the total population of 36,000, only 10,000 have survived including 3000 wounded. The general public opinion, however, places the summer population of Quetta at a much higher figure than the official estimate of 36,000, and hence supposes that the number of casualties is much larger. This figure does not include the casualties in the neighbouring area and other smaller cities.

It is natural that disasters like the present one strike not only terror, but also excite much moral and intellectual speculation. The present age is too much sophisticated to give credence to stories of divine wrath and the like. But the very fact that a quake of the earth's shell barely lasting for two minutes, can completely wipe out of existence whole cities and countries built up as a result of scores of years of patient enterprise, labour, and engineering skill, gives us sufficient food for reflection; but we do not wish to speculate on the mystery regarding the origin of the universe or of this earth, or wish to comment on the theological speculation regarding the origin of the great natural calamities which sometimes affect mankind. These are questions which, we are afraid, will ever be beyond the comprehension of the human mind.

The scientific man now knows that the earthquake is a purely physical phenomenon, governed by the laws of nature, and we shall tell our readers in plain language something about the knowledge acquired about earthquake phenomena as a result of scientific studies carried out so far.

It is true that, in the past, earthquakes have been very frequent, and sometimes very disastrous over the whole of Northern India along the foot hills and in the plains below the Himalayas and its extension to the further south, covering Baluchistan right upto the south as far as the Kathiawar peninsula. But there does not seem to have been on the part of the Hindu and other savants of antiquity any attempt to understand the earthquake as a natural phenomenon. Besides the great historical earthquakes of which we are aware, there must have been some very terrible ones in the past, of which echoes remain in the myths and legends preserved in the old scriptures. We may refer to one or two of these stories. There is a legend in the Mahabharata that N. Bihar (Mithila) was once ruled by a dynasty of kings who bore the title of Janaka. Dr. H. Roy Choudhury and other competent historians regard this dynasty as historical, having flourished in Bihar between 1200 B. C. and 700 B. C.; the kings of this dynasty were regarded as great philosophers and patrons of learning, and Upanishadic learning flourished under their fostering care, but it is recorded that the last of them, Kalar by name, unlike his predecessors, was a great scoundrel and was ***sent to hell with his capital and kingdom*** by the curse of a sage to whom he had given great offence. Probably the story refers to the sudden destruction of the last Janak's kingdom and capital by a great earthquake occurring in the 7th century B. C. which was far more intense than the Bihar earthquake of 1934. The later writers as usual saw in this phenomenon an expression of ***Divine Displeasure*** at the wicked ways of man, and utilized it to illustrate their moral theme. There is another story which says that Krishna's capital, Dwarka, which was to the west of the Kathiawar Peninsula, was swallowed up by the sea when Krishna's clansmen fell by each other's hands, and the great hero departed to heaven. Probably the story refers to a great subsidence of this part of the peninsula due to a great earthquake,

similar to the one occurring in 1819 in the very same region, which led to the formation of an inland sea, called the Runn of Cutch, and disappearance of the Sindri fort below the waters of this inland sea. Many other stories, alluding to what seems to us to be earthquakes, may be reproduced here, but a consideration of space does not permit us to do so.

It may be said that other countries have also looked upon earthquakes as expressions of divine displeasure. We may refer to the biblical story of Sodom and Gomorrah, and the formation of the Dead Sea.

At the present time scientific men are being assailed in the press, because inspite of their efforts and the ridicule they pour on the theologian and the astrologer, they have failed to predict the occurrence of such disasters. The ubiquitous astrologer has come forward with the claim that he foretold the calamity. It is noteworthy that such claims are always made after the disaster. But the scientist still owes some apology to the public as to why he is unable to give timely warning of such disasters.

Beginning of Scientific Study of Earthquakes.

It is said that in 132 A.D. a Chinese savant, named Choko, designed an apparatus which may be described as a primitive *seismograph.* In Europe the scientific study of earthquakes is very recent. We may say that it was started by an Irish engineer, Robert Mallet, who, in 1859, induced the Royal Society of Great Britain to give him a research grant to enable him to proceed to South Italy and compile a report about an earthquake which had devastated Naples and its surroundings in the previous year.

Mallet performed the task with great care, and laid the foundation of the *Science of Seismology* (from *seismos,* meaning a quake). His studies were mainly descriptive, that is, he gave an account of the damage done, the direction in which the disturbance happened to work, and also reported about changes in the geological formation in the affected locality. Later on, towards the latter half of the last century, a number of pioneers, Milne and Omori in Japan, Wiechert in Germany, and Gallitzin in Russia, invented sensitive apparatus (called *seismographs*) for recording the movements of the earth. Japan has been a pioneer in the science of seismology, because she suffers from frequent and very destructive earthquakes. About 1880, Professor Milne, who was then in the Japanese Educational Service, founded the first seismological institute which has now grown up into the *Imperial Seismological Society,* and is the most well-equipped and well-staffed research institute of its kind in the world. Next to Japan, in seismological investigations, comes Italy which also suffers from frequent and very destructive earthquakes. Next come Germany and Russia. Not much seismological studies are carried out in England, as that country does not fall within the earthquake belt. Within the whole historical period, only one man was killed in London in 1580 by the falling of a building in London due to an earthquake which had its origin in Portugal. America woke up to the study of earthquakes after 1906, when the city of San Francisco was devastated by a great earthquake.

In India, the earthquake investigations are carried on by geologists and by the Meteorological Department. The work done by the geologist is more like a *post-mortem* examination. After every earthquake, officers in the Geological Survey of India rush to the place of occurrence, study the amount of destruction and the changes in the geological formation and draw curves, showing regions of equal seismic disturbance *(iso-seismic lines).* They thus try to determine the place from which the earthquake has originated *(epicentre of disturbance).*

It is now generally recognised that the earthquake is due to movement in the earth's crust which produces some cataclysm at some depth (usually called the *focus*). The epicentre is just above the focus, and is generally the place where the maximum destruction takes place, but though the focus is just below the epicentral tract, it is difficult to locate its depth exactly.

The Geological Survey of India has published a number of valuable memoirs on the

great earthquakes which have visited India since 1897, the year of the Great Assam Earthquake, which was reported very fully by R. D. Oldham. The other reports are of the Kangra Valley Earthquake of 1905, the Raymangal Earthquake of 1914, and the Bihar Earthquake of 1934, which is sill in preparation.

The few recording seismographs which are to be found in India are generally under the Meteorological Department. The stations are Colaba, Agra, Alipore, Kodaikanal, Hyderabad, Deccan (belonging to the Nizam State), and at Oorgaum (Kolar Gold fields, Mysore) and Colombo, Ceylon. There is also a seismograph at Dehra Dun under the Trigonometrical Survey of India. In contrast to the Geological Survey ***these instruments may be said to record the daily pulse of the earth and also its violent fits which we call earthquakes.*** We reproduce in this issue the record of the Great Quetta Earthquake by the Alipore seismograph which we owe to the courtesy of Dr. S. N. Sen, meteorologist, to whom our sincerest thanks are due.

It may be rightly argued that it is no comfort to the man whose property and family lie buried under the debris of a devastated city to be shown a ***seismogram*** with which the scientist is able to locate the disturbance as soon as it occurs, and to make some estimate of its intensity. The public wants some more concrete achievement which will ensure him certain amount of safety against the occurrence of such calamities in future.

We should frankly admit that inspite of intense effort, lasting over half a century, the earthquake scientists have not yet been able to trace the causes which lead to the cataclysm inside the earth resulting in a catastrophic earthquake. A discussion was held last year under the auspices of the Indian Science Congress, in which the Indian scientific men of different sections tried to present the points of view of their respective sections regarding the origin of earthquakes. There are scores of theories, but none are satisfactory and it appears that years of labour are still ahead before the world can be in possession of the knowledge which will yield some clue to the origin of this mysterious phenomenon.

Need for appointing an Earthquake Commission.

Now that India has suffered from a number of successive catastrophic earthquakes within a short period, we should impress upon the government the desirability of appointing an Earthquake Commission, composed of geologists, physicists, meteorologists and engineers with the following objects in view.

The commission should be expected to report to the government on the desirability of starting an ***All-India Seismological Society*** for a cooperative study of earthquakes in which the universities should be invited to take part as in the case of the Agricultural Research Work. This purpose is achieved in Japan by the ***Imperial Seismological Society*** and the ***Earthquake Research Institute*** of Tokyo in collaboration with other branch institutes and university research departments. The workers in this institute are carrying on a systematic investigation of the geological formation of Japan, not only on the surface, but also in the interior of the earth with the aid of sensitive physical apparatus, particularly the ***Eotvos Gravity Balance.*** This is a very sensitive balance, discovered about forty years ago by Baron von Eotvos, a Hungarian physicist, and is now extensively used by mining companies for prospecting purposes. (Such gravity surveys are very desirable in the case of India, in view of the instability of the earth's crust all along Northern India giving rise to frequent earthquakes, and of the divergence of opinion held by different schools of scientists regarding the composition of the crust, its loading and variation of level with time due to physical changes taking place underneath the crust). Besides such work, the Japanese Institute also carries out by means of modern experiments very important investigations on the damage done to different types of buildings by earthquake thrusts.

To determine the acceleration which the moving ground imparts to a building or column,

"Shaking Table" experiments are being carried on in Japan and lately also in America. A table on which model structures in artificial conditions (such as on sandy or clayey beds etc.) are placed, is given known and controlled motion and the acceleration and motion of the structures are directly measured. How these results obtained in miniature scale are to be modified for actual big structures on natural ground, technically known as the problem of similitude, is not yet definitely known. A knowledge of these will help the structural engineers in making quake-proof constructions. Formerly the Japanese buildings used to be made of very light material, under the idea that even if the buildings collapse, the occupants will not be much hurt. But when, during the Tokyo Earthquake of 1923, more people perished by the conflagration which started after the earthquake, than by falling of houses, the Japanese Government directed certain model experiments to be performed in the research laboratories; acting upon the advice of their scientific experts they introduced certain building regulations which are said to have greatly minimised the dangers of damage and loss of life in subsequent shocks.

Further, in India we should have a string of stations in and around the quake zones from which records should be transmitted to a central station for ***synoptic*** study. Observations on extensive scale over the areas in question should be carried out to test the statement of some Japanese seismologists that systematic earth tilts often precede earthquakes, to judge about the applicability of such results to Indian conditions. A combination of seismologists, geologists and engineers is to be brought about to devise ways and means of every possible kind for protection of life and property from severe earthquakes.

These points are extensively discussed in the review of ***Earthquake Damage and Earthquake Insurance*** by Freeman which treats the matter from the view of insurance of buildings against earthquakes.

The earthquake at Quetta is said to have caused a damage of ten crores of rupees in property alone, not to speak of the loss of thousands of precious human lives. One hundredth part of these losses, spent in founding research laboratories of the type we have mentioned, would be a justifiable expenditure from the public exchequer.

The duty of science is quite clear. Though so far it has not yet succeeded in tracing the origin of these catastrophes, much less in predicting them, there is no reason to think that success will not come some day. Mankind watched for six millennia the mysterious motions of the planets, before a Kepler came and disentangled from the mass of observations the laws governing their motions. With respect to the earthquakes, it is true that we are simply collecting data; the present thinkers are groping in the dark like Kepler, in the hope that they will see the light some day. When that light comes, they will be able to repeat to the layman the same remarks which Kepler made when people tried to belittle his great achievement on the plea that his laws were so simple that anybody could discover them. "If God Almighty could have waited for five thousand years for a Kepler to find out the laws which govern the motion of the heavenly bodies, Kepler can wait for at least a century more for people who would be able to appreciate the full value of his discoveries." But Kepler had not to wait for a century, and probably the earthquake scientists will have to wait for a lesser period.

Earthquake Damage and Insurance

Earthquake Damage and Earthquake Insurance *by R. John Freeman. Mc. Graw-Hill Book Company. Inc. New York and London.*

The book under review presents a splendid collection of facts regarding earthquake damages, particularly to all kinds of masonry work and describes attempts made in various countries to evolve engineering structures strong enough to resist the destructive force of severe earthquakes. The view point of the author is that of earthquake insurance, and he expects that his study will arouse public interest in the subject in America, leading to provision of funds for the much needed study and research which will be helpful to structural engineers to find out means for better protection of life and property. Though the ultimate findings of the author are addressed to Insurance Executives, the book is of considerable interest to science. It will be difficult to find a single volume containing pertinent details of the study by scientific men of all the recent destructive earthquakes upto 1930 in different parts of the world. The assessment of every such earthquake as regards its degree of violence, the extent of the area over which its destructive forces have been operative, the kinds of structures which have succumbed and those which have successfully withstood the violence in that area, the geology of both the seriously affected areas as well as of areas which fortunately appeared to escape destruction, the damage and loss in proportion to sound value of property, have all been studied in detail and with punctilious care. The author then draws his own conclusions which he has taken every opportunity to emphasize to the utmost degree. To amateurs who desire to know what human efforts have done upto now to escape destruction by earthquakes (and there will be many such persons at this moment in India), the book, though rather bulky, may undoubtedly be recommended.

The findings of the author are set forth clearly in separate chapters and refer to conditions in the States. The author first stresses the fact that the zones of greatest earthquake activity are limited and well defined. The zones of serious destruction are relatively small, and important damages to structures at a distance of more than 25 miles from centre of disturbance are very rare. (The statement will not apparently apply to the last Bihar Earthquake where the ravages extended from Nepal to a good portion of North Bihar). A study of recent earthquakes in the United States and Canada, however, shows that in any one quake, the total area over which serious destruction of buildings has occurred, has never exceeded 10 sq. miles, except in a single case. Secondly, the author (who is an experienced engineer himself) concludes from personal inspection of affected areas in California, Japan, China and from information collected by seismologists and builders in those countries as well as in Italy that the destructive activity of the quake has been confined mostly to weaker buildings built on unstable ground ; while those which could resist were particularly designed for that purpose. Buildings not exceeding 100 ft. in height and made sufficiently rigid and capable of resisting a horizontal acceleration of one-tenth that of gravity will, in the opinion of the author, generally meet the requirements of earthquake-proof constructions (specially in the States). Subject to certain conditions laid down for construction and previous inspection by engineers, the author concludes that the inclusion of a clause covering earthquake risks in ordinary fire insurance at small extra cost will safely be possible.

To the present day seismologists, the book will not probably say much that is new, but the author's complaint that modern seismology and geophysics have carried their study

on too theoretical grounds devoid of human interests deserves respectful attention. The following lines quoted from a certain letter at the end of the book will show the depth of his feeling in the matter. "*The registration of an earthquake two thousand miles away can hardly be expected to interest a man whose family lies buried beneath the ruins of a house built of improper materials upon ground that any geologist might have told him to keep away from.*" Seismologists have perfected sensitive instruments to register distant quakes with all their components. From these records they calculate the origin of the quakes and their calculations throw light on the geology and physics of the ground underneath. What the structural engineer wants is accurate knowledge of the acceleration and amplitude of vibration of violent earthquake motion within the zone of destruction and the response made by large rigid structures to the quake motion. These data are essential to the structural engineer for construction of earthquake proof buildings. Modern seismologists in different countries, have paid little attention to the direct measurement of these quantities. Japan, however, is a noble exception, where seismological studies under the inspiration of the State are in a most organised condition.

There is much interesting information for the general reader spread all over the book. It is first noted that the earthquakes may have volcanic or tectonic origin. The first type is associated with volcanic activities, and has a shallow origin. The area affected is very small not exceeding a few miles from the centre of disturbance. The more serious are tectonic earthquakes which are responsible for most damages. The earth's outer crust to a depth of about sixty miles is not in a stationary state. Due to transfer of material by erosion and sedimentation or to shrinkage, strains etc. gradual stresses are developed and stored up in the elastic rocky crust underneath and in case these stresses exceed the elastic limit of the rocks, the latter are suddenly ruptured. The elastic set back produced sends a series of waves which travel both through the earth and over the surface. The shock felt at a distance somewhat resembles a hammerblow followed sometimes by a few regular wave like movements. The surface waves are the most destructive though the actual displacement of particles of matter in a building seldom exceeds 1 inch. But the sudden acceleration produced can be great. In the last Japanese Earthquake of 1923 acceleration of about one third of that of gravity was also noted in some places. The damage to property is much greater on alluvial soil than on solid rocks. In the last Japanese shock it was found later by careful observation that the soil of alluvial formation was shaken fully three times as intensely as the ground of diluvial formation. It is an interesting fact that about 95% of the total damages in the recent earthquakes in America (this is also true of the last Great Japanese Earthquake) was caused by fire and only about 5% directly by the quake. This is of immense importance to underwriters and one of the reasons which led the author to his conclusion regarding earthquake insurance. The effect of shocks on different types of buildings has been very amply illustrated in the book by photographs in chapters vi-xi. The study has not been limited only to American quakes but the author has taken all opportunities to collect information from visits to affected areas after quakes in Japan, Italy and Central America and has piled up materials from these sources.

A noteworthy feature of the book is the space devoted to the account of the study and research in earthquake in Japan. There is an Earthquake Research Institute in the state University of Tokyo where systematic and continuous work on earthquake is carried on. After the last great earthquake a group of engineers and seismologists under the authority of the Japanese Government, prepared a report on the nature of and the damages caused by the earthquake. This was published in the Japanese language by the Japanese Society of Engineers and is the most complete report on any earthquake published anywhere in the world. The author had certain portions of this report translated into English from which ample quotations have been made. There is a

brief account of three important instruments constructed by Kyoji Suyehiro, director, Earthquake Research Institute for precise measurement of quake motion, namely a tiltmeter measuring changes in ground slope to a decimal of a second helping to find correlation, if any, between progressive earth-tilt and occurrence of an earthquake, an accelerometer for direct measurement of ground acceleration, and a seismic vibration analyser to detect the quake periods, predominant in different regions. The theory of Dr. Naito's (a Tokyo engineer) earthquake proof constructions, little known outside Japan (for his publications are all in Japanese language) has been discussed at some length. Dr. Naito advocates a rigid construction whose natural period of vibration will be smaller than the probable period of any violent earthquake motion. Such buildings have been found to be unaffected by the destructive earthquakes. In Japan methods have actually been developed to measure directly the free periods of vibration of buildings. For structural stability, a great deal of importance is laid by Japanese engineers on ground plan shape (rectangular and square shapes being stronger than L, E or U shape),on symmetry of wall openings, re-inforced concrete walls and rigid floors. Braced buildings with walls and bents with diagonal bracing are in the opinion of Dr. Naito, best suited to resist severe quake havocs.

Chapter XII which deals with the prediction of time and place of occurrence of future earthquakes will be read by the layman with great interest. Though seismologists agree that in the present state of development of science no prediction of any value is possible, there have been cases in which recent quakes have been predicted by seismologists. The approaching catastrophe at Tokyo in 1923 was actually forecast by Omori, the celebrated professor of seismology in the Imperial University, though the exact time was not predicted, from his records of continuous observations for years. Volcanic quakes can be predicted much better and there is one of Mount Pelee by Prof. Jaggar. Some Japanese experts lay much stress on continuous measurements of slow earth-tilt by clinometre as a means of predicting earthquakes, as earth-tilt is sometimes regarded as a forerunner of earthquakes. This tentative method is being tried by extensive measurements in Japan at the present time.

After the recent tragedies in Bihar and Baluchistan in quick succession, the average Indian has ceased to look upon the study of earthquakes with a mere idle curiosity. It is being slowly recognised that protection of human life and property requires the study of the subject in an intense manner. We have to take the cue from Japan in this matter. The State instead of appointing a Commission of expert geologists and seismologists to report on the quake after such a disaster involving appalling loss of life and property, as has been the usual practice, should wake up to the necessity of doing something on the line of Japan and helping to intensify the study of earthquakes by establishing a series of continuous observation stations in suitable places and encouraging research which will extend our knowledge of the complicated character of quake motion and supply necessary data to structural engineers to design simple and less costly earthquake-proof construction suitable for this country. An admirable scheme of research on earthquake has been set forth at the end of the book under review which may be taken over with suitable modifications. Lastly it must not be forgotten that the study of earthquake includes the possibility of perfecting methods of prediction of destructive quakes, which will certainly be the most effective life saving device. For though at the present moment it is outside the range of practicability it may not remain so even in near future.

N. R. Sen.

The Quetta Earthquake

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The severe earthquake shock which has devastated Quetta and its neighbourhood at about 3 hrs. (I.S.T.) on 31st March, 1935, apparently had its origin at latitude 30½° N and longitude 66½° E. The position is determined from the following data:—

Station.	Epicentral distance.	Time of beginning of the shock at the station.	Computed time of beginning at the epicentre.
Bombay	920 miles	3 h. 5 m. 33 s. (I.S.T.)	3 h. 2 m. 22 s. (I.S.T.)
Agra	690 „	3 h. 4 m. 54 s. (I.S.T.)	3 h. 2 m. 28 s. (I.S,T.)
Calcuttta	1470 „	3 h. 7 m. 36 s. (I.S.T.)	3 h. 2 m. 48 s. (I.S.T.)

As can be seen from the map below, the region approximately coincides with the Khojak Range at the border of Baluchistan and Afghanistan just to the south of Chaman. The epicentre is roughly about 60 miles to the north-west of Quetta.

Fig. 1

The shock was so violent that the three seismographs at Alipore Observatory were, for a time, put out of action soon after the Rayleigh waves arrived. The trace of the Omori-Ewing Seismograph (East-West component) is reproduced below:—

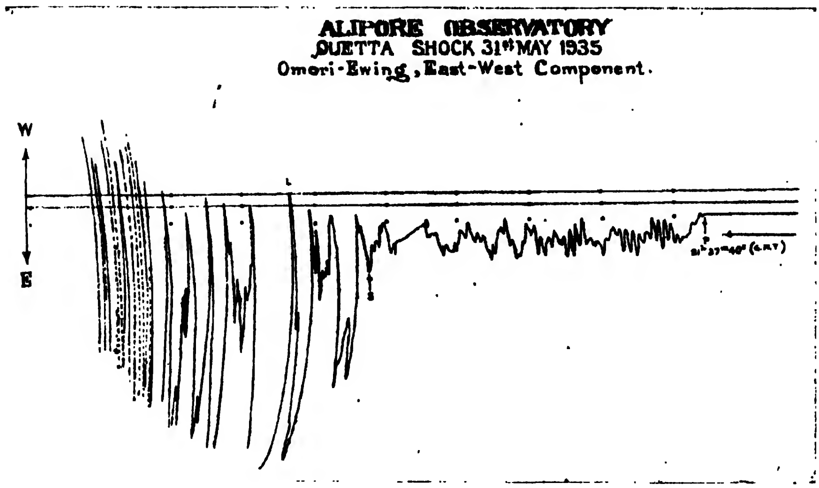

Fig. 2

The Alipore seismographs did not record any foreshocks. A few aftershocks have however been registered. One of these aftershocks was moderate in intensity and occurred at 14 h. 51 m. (I.S.T.) on the 2nd June, 1935. The Milne-Shaw record of this shock is reproduced below :—

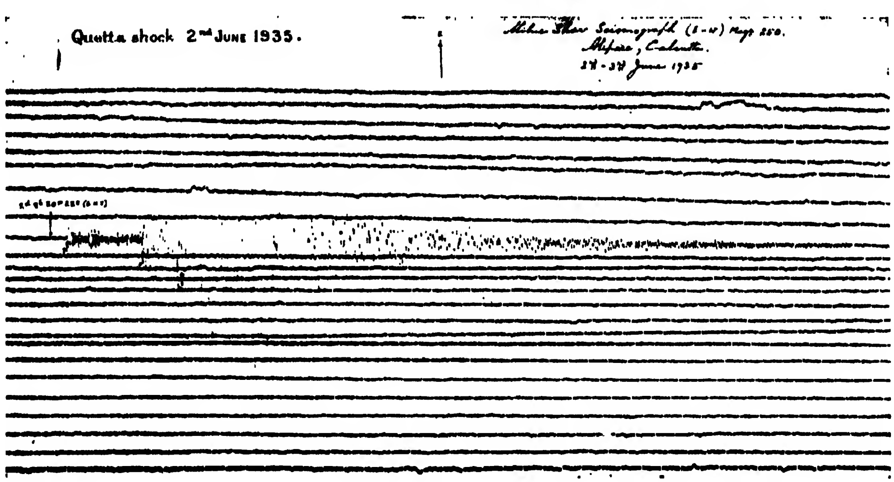

Fig. 3

It may be mentioned here that the severe Baluchistan earthquake of 20th December, 1892. also originated at the same place. According to Griesbach (Records of Geological Survey of India 26, 57-54 1893) this shock was caused by a displacement on a fault which flanks the Khojak mountains on the west by about 2½ ft. It was discovered later by Col. McMohan that there is a fault about 120 miles long, running from Murgha Chaman (some 18 miles north of Chaman) to Nuski. It is alleged that after severe earthquakes, which are not uncommon in the locality, deep fissures appear along the fault. It would be interesting to know whether in the recent earthquake there has also been a slip along the Chaman-Nuski fault and whether fissures have since appeared.

The Application of the Statistical Method in Industry

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Introduction.

Until recently the statistical method in industry has been associated with practically one single group of problems, namely marketing. But during the last 3 or 4 years, rapid developments have taken place in the application of the statistical method to technical problems in industry. There is a growing realization of the benefit which industry may gain by the use of analytic statistics to a whole range of problems that arise in the course of routine production such as the purchase of raw materials, control and standardization of the quality of manufactured products; problems of sampling and testing etc. There are also special research problems in industry which involve careful planning and experiment, and which require the same kind of statistical control and analysis as agricultural field experiments of the new type. An attempt has been made in the present note to give a general idea of the scope of the statistical method in industry, but owing to the highly mathematical nature of the subject it has not been found possible to touch any of the technical details.

Control of Purchase of Raw Materials.

In making bulk-purchases (whether of raw materials or of partly or fully manufactured products) it is usually not practicable to test every unit of the purchased goods. For consumable commodities like coal or electrical fuses, which are destroyed during the process of testing, such complete tests are of course even theoretically impossible.

Thus the need constantly arises for estimating the quality of a large batch or consignment of similar material from the inspection of a small amount drawn from the larger whole. We are therefore obliged to have recourse to the method of sampling tests carried out on a small fraction of the total purchases. (The term 'sample' is used in this note in its statistical as distinct from its ordinary commercial sense. Thus a 'sample' consists of a number of individual units for each of which one or more characters have been or are going to be measured and recorded; it is often usual to speak of these measured values themselves as forming the sample).

From the purchaser's point of view three things are important:—

(i) the goods purchased must attain a specified standard;

(ii) the quality received by him shall remain uniform from one consignment to another; and

(iii) the amount of sampling tests he has to carry out should be reduced to a minimum, consistent with safety.

We must take into consideration the existence of variation in this connexion. For example, the percentage ash-content of coal from the same source of supply may vary by 50 or 100 per cent; different test specimens from the same batch of yarn vary in strength by 50 to 100 or more per cent; the length of life of electric lamps of marked voltage may vary from one lamp to another by 200 or 300 per cent. and so on. Testing a single unit will clearly be inadequate. The question naturally arises, how many units must be tested in order to attain a given degree of accuracy? How should the units in the sample be chosen? For example, in sampling raw cotton, is one handful representative of a bale, or is one bale representative of a consignment? Is it better to choose 500 hairs singly, say 50 from each of the 10 bales in a consignment, or should they be chosen in tufts of 50? In sampling coal, should we take a handful from a single sack, or take samples from a number of sacks? In testing electric

lamps, should we take 100 samples of 2, or 40 samples of 5 or 2 samples of 100 lamps? When it is remembered that there may be variations within a unit; between units in the same consignment; between consignments from one source of supply; between sources of supply; and between supplies at different seasons, the complexity of the problem will be easily realized.

We have already mentioned that the existence of variation must be accepted as a basic fact of experience. The knowledge of 'mean value' alone is therefore practically useless, and it is essential to take into consideration the nature and amount of variation present. This emphasis on the study of variation distinguishes modern analytic statistics from the older enumerative statistics in which totals or mean values only are of importance. The magnitude of variation is usually measured by what is technically known as the "variance", or its square root, the "standard deviation". The 'variance' is simply the average value of the squares of all deviations from the mean, and is obtained by taking the sum of squares of all deviations from the mean, and dividing this sum by the total number of deviations. It is clear that the greater the magnitude of variation, the larger will be the value of the variance.

Statistical control is based on the important fact that for homogeneous material both the mean value and the variance remain sensibly constant. In fact such stability of the mean value and of the nature and magnitude of the variation (as measured by the variance) are the only criteria of homogeneity. The size and number of samples will for example obviously depend on the magnitude of the variance. Other things being equal, a larger size or a larger number of samples will be required to attain the same degree of accuracy when variance is large than when variance is small. The probable limit of variation from one sample to another will also clearly depend on the value of the variance.

Thus once the mean value and the variance are known, it becomes possible to prepare a complete testing scheme on the following lines:

(1) A standard programme is prepared for routine testing which will include detailed instructions regarding (i) the size of samples, (ii) the method of taking the samples, (iii) the number of samples, and the interval at which they should be taken. It is usually convenient to arrange for the results of the sampling tests being plotted on graphical control charts.

(2) An upper and a lower "limit of safe variation" will be marked on the control chart, such that so long as the observed results of sampling tests fall within these limits it may be assumed that the quality of the material is controlled and is remaining sensibly uniform.

(3) A second pair of "danger limits" lying outside the "safe limits" will also be marked on the charts. If the result of a sampling test falls outside these danger limits it will signify an appreciable departure from uniformity which requires special investigation.

(4) If the result falls in the region lying between the safe and the danger limits, that is, falls in what may be called the "warning belt", it will indicate that the situation is suspicious. It will then be advisable to repeat the sampling test until it becomes clear whether the control has broken down or not.

The advantages of such a scheme of statistical control are many. It will reduce the cost of testing to a minimum, consistent with safety. It will give immediate warning of any suspicious increase in variation, and will give definite indications of any appreciable departure from uniformity of quality. Once the control system is properly designed it will practically work automatically until the danger zone is reached, when of course special investigations will again become necessary. Finally the method is extremely elastic, and the testing programme can be adjusted to suit any desired degree of accuracy.

The degree of accuracy itself must of course be fixed from considerations of a practical nature. If the specifications are stringent the cost of testing will be large, for larger or more numerous samples will be required. An inadequate specification on the other hand will cost very little in sampling tests, but will be practi-

cally useless. There will be an optimum degree of accuracy and amount of testing for a particular material or industry, and this optimum must be determined with the help of statistical analysis.

Routine Control of Quality of Manufactured Products.

Similar statistical problems arise in attempting to control the quality of manufactured products. Even when the quality of the raw material is kept fairly uniform, numerous factors such as temperature, humidity, rate of working etc., cannot be fully controlled, and consequently the product varies in quality. The statistical aim at this stage is two-fold. The first objective is to eliminate assignable causes of variation in quality. For example, in many industries the quality of the product varies considerably with humidity. A manufacturer may therefore want to know whether it is worth incurring the heavy expenditure of installing a plant for artificial humidification and air conditioning. By correlating daily output and quality of the manufactured product with daily humidity records for the (as yet) unhumidified factory, the statistician can often make an estimate of the probable gain in production to be expected from the installation of a plant, and thus help the manufacturer in making a decision.

In many instances the economic efficiency (or rather, inefficiency) of production is measured by the the fraction of the manufactured product which fails to conform to the engineering specifications, or by what is usually called the fraction defective. Under controlled conditions this fraction should fluctuate within a normal range of variation. If it is found that the variation is irregular and often greater than this normal range, we shall have every reason to suspect the presence of some gross or definite cause of variation. Now it is clear that even when the average quality of the product remains constant, the proportion of defectives will inevitably rise when the range of variation increases. To reduce and control the magnitude of variation is thus of prime importance in such cases. All assignable or systematic causes of variation (the existence of which is indicated by statistical analysis) must therefore be eliminated by suitable improvements or changes in manufacturing processes until the statistical test assures us that the fluctuation has been brought within normal limits.

Once the assignable causes of variation have been eliminated, it becomes possible to attain the second object of statistical control, namely, the setting up of a routine programme of testing which should be adequate but not too costly. The plan for such a test programme will naturally be very similar to that already described in paragraph 3, and will consist of detailed instructions regarding size and number of samples, methods of collecting them, and control charts with double sets of 'safe' and 'danger' limits.

The setting up of such a system in a factory, the elimination of assignable causes of variation by gradual changes and improvements in the process of manufacture, and the use and interpretation of routine tests for investigating causes of variation require an intimate acquaintance with the working of the factory as well as the most refined statistical technique. The essential need for co-operation between engineers and statisticians cannot therefore be overemphasized.

Specification and Standardization.

The growing strength of the movement for national and international standardization of materials shows the industrial importance of the subject. The degree of accuracy of specifications and of standardization which can be attained in practice ultimately depends on the variability of the quality of the manufactured products, and on the reliability with which such variability can be estimated.

It is being more and more widely recognized that uncontrolled variation is the most potent source of inefficiency in every direction. Once a fairly satisfactory level of average quality is attained, a reduction in variability becomes usually more important than a further improvement of the quality. Consider, for example, the

tensile strength of malleable ironcastings. Even when the average strength is high, if variability is large, the marginal "factor of safety" must be kept large in order to ensure the strength not falling below the minimum requirement. Provided the variability can be appreciably reduced, it will be clearly possible to lower the "safety factor" without any increase in the average strength ; in fact when variability is small such reduction of the "safety factor" may even become possible with a lower average quality. It is likely therefore that many of the "safety factors" used in engineering practice could be reduced without danger, provided the variability were reduced and estimated with greater precision.

Standardization of specifications thus calls for reliable estimates of the average quality as well as of the variability in the quality of the material. The need for sampling programmes and of the use of statistical analysis for this purpose is thus clear.

Problems of Management and the Human Factor.

Statistical methods are equally indispensable for the analysis of variations caused by the human factor. In fact statistical analysis has functioned as the basic tool in practically recent investigations in industrial psychology in dealing with a large variety of problems such as the influence of temperature, humidity, monotony, rest-pauses and other conditions of working on the quality and quantity of output ; investigations on accident-proneness and prevention of industrial accidents ; selection of employees ; efficiency of methods of training ; fluctuations in labour turn-over ; time-studies of the rate of production in relation to stoppages of machines and unequal distribution of work ; comparative efficiency of operatives and methods of organization etc. Besides these recent developments, the statistical method has been, and is still being, extensively used in connexion with the study of marketing problems of all kinds including cost analysis, comparative efficiency of advertisements, market surveys, business forecasting and industrial planning.

Statistical Control in Industrial Research.

The primary object of industrial research is the comparison of different kinds of raw material, of different types of machinery, or of different technical processes to find out which gives the better or more uniform quality of product or a larger output. Under laboratory conditions the different factors can often be isolated and studied separately, but this is usually impossible under actual factory conditions of production. It therefore becomes difficult or impossible by ordinary laboratory methods to disentangle the different causes and effects in order to study the relationship between the factors under investigation. Recourse to the statistical method is thus inevitable, and it is necessary to consider statistical principles in designing the experiments. The general aim is to try to balance out all the uncontrolled factors of variation. The basic problem from the statistical point of view is practically the same as in agricultural experiments of the new type in which the effects of different "treatments" are compared with the help of suitable randomized designs. For example, Dr. R. H. Pickard D. Sc., F. R. S., Director of the British Cotton Industry Research Association, has explained in a recent paper how the well-known "Latin Square" design of agricultural field experiments was used with great success in an investigation on the influence of "wettability" of a cloth on the rate at which number of experiments could be reduced by half for given standard of significance.

It is claimed that the use of the modern statistical technique in industrial research has the following advantages :—

(1) Owing to the statistical control in the design of the experiment it is possible to obtain valid results by eliminating the effect of chance factors.

(2) The precision of the comparisons is increased appreciably, and all results are obtained in terms of the probability scale.

(3) It usually becomes possible to reduce considerably the total number of experiments thus effecting a substantial saving of both time and money.

(4) The simultaneous study of a number of factors is rendered possible by a design of a "complex" type. It thus becomes possible to study the "inter-action" or mutual reaction of different factors. Such studies are altogether impossible in the older type of research in which the different factors are investigated separately and in isolation.

(5) With the help of correlational analysis it becomes possible to study the inter-connexions between different sets of factors, and thus obtain a greater degree of control in many cases.

Advantages of Statistical Controls in Industry.

It will be seen from the preceding discussion that statistical analysis can provide industry with a scientific basis for the establishment of economic standards of quality, and an essential tool for the maintenance of such standards under routine conditions of large scale production. The use of the statistical method will give adequate control over the quality of materials purchased in the bulk; reduce the cost of routine inspection and testing; help in reducing the magnitude of fluctuations in the quality of manufactured products, and by eliminating assignable causes of variation reduce the proportion of defective; make it possible to reduce without danger the 'factors of safety'; make specifications more reliable, and thus help international standardization; furnish an effective tool for the study of problems of management involving the human factor; and finally increase the efficiency and reliability of experiments in industrial research.

Actual experience has shown that the cost of using statistical controls is comparatively a small item, and is usually fully worth while from a purely business point of view. It is claimed in fact that the statistical method is indispensable for the elimination of waste, and for attaining economic standards of efficiency in production.

Recent Developments in Western Countries.

Dr. W. A. Shewhart of the Bell Telephone Co., U. S. A. published in 1931 an important book on the *Control of Quality of Manufactured products* dealing exclusively with the application of the statistical method (especially the theory of sampling distribution) in industry. A little later a Joint Committee was set up for the development of statistical methods in the U. S. A., by the American Society for Mechanical Engineers and the American Society for testing Materials. Dr. Shewhart was invited by the University of London to give a course of lectures in London in May 1932 on the *Role of Statistical Theory in Industrial Standardization.* This immediately led to the British Standards Institution calling a conference of representatives from several different engineering groups, scientific societies and research institutes, and a committee was appointed under the chairmanship of Mr. B. H. Wilsdon of the Department of Scientific and Industrial Research to draw up a report on the subject. Similar action was taken in Germany at about the same time by the Deutscher Normensausschuss.

Dr. Egon Pearson of the Biometric Laboratory, London, contributed a paper on the quality-control of output to the York meeting of the British Association, and read an important paper before the Royal Statistical Society in December, 1932, on *Statistical Method in the Control and Standardization of the Quality of Manufactured Products* which attracted a considerable amount of attention. The subject was discussed in a special article in *Nature* on October 29, 1932, and again on December 24, 1932, and it was suggested that provision should be made in the Biometric Laboratory for the development of education and research in this subject. The question was immediately taken up, and a new Department of Applied Statistics with Dr. E. S. Pearson at its head was created by the University of London in October 1933.

In the meantime a Committee had been appointed by the Council of the Royal Statistical Society for forming an organization which would provide facilities for the consideration of the problems involved in the application of statistical methods to industrial and agricultural research: and a new 'Industrial and

Agricultural Section' of the Society was formed on November 23, 1933, when Dr. R. H. Pickard, F.R.S., Director of the British Cotton Industry Research Association, read a paper on the *Application of Statistical Methods to Production and Research to Industry.*

A Scheme for India.

In view of the practical importance of the subject it is suggested that provision should be made for its study and its application to problems of industrial production, organization and research in India without further delay. The introduction of the statistical method is likely to prove immediately useful in India in connexion with the testing of raw materials and manufactured products of all kinds, in railway workshops, telegraph and telephone engineering etc, and in such industries as textile, iron and steel, jute, coal, sugar, leather, paper etc.

It is suggested that the actual testing and the collection of primary data will be done by engineers and technologists under factory conditions or in testing laboratories, and the data will be reduced and analysed in the statistical laboratory. The statistician will prepare testing programmes, while the technologist will try them out under actual working conditions and send the results to the statistician for analysis and interpretation. In the beginning the work will necessarily be of the 'trial and error' type, but with the accumulation of data relating to the variability of the material or product under investigation, it will gradually become possible to set up a permanent programme with standardized control charts. This will enable the work of testing to proceed on routine lines without further reference to the statistician until there is a break-down of the control. Again in special investigations (rendered necessary by such break-downs, or in industrial research) when assignable causes of variation will have to be traced and eliminated, the design for conducting experiments will be prepared by the statistician, while the actual exprimental work will be done by the technologists. In this way by close co-operation between technicians and statisticians the complicated problems of industrial production can be studied in all their intricacies in the most efficient manner.

India is admittedly backward in industry. The need for using modern methods of scientific research is therefore all the more urgent. Analytic statistics has been found to be a most powerful tool for this purpose in the western countries. It is bound to prove even more useful in India where urgent problems of all kinds require solution in every direction.

The application of the statistical method has already been started in a small way, mainly on the theoretical side, in the Statistical Laboratory, Presidency College, Calcutta. An attempt is being made to keep a record of progress in various fields in western countries. Detailed information and free advice on any point will be gladly supplied to industrialists, technologists and other persons, interested in Indian industries. The Laboratory is also prepared to undertake research problems of all kinds including the preparation of control charts, designs for routine sampling and technical experiments, interpretation of statistical data, and to co-operate in other ways for advancing the cause of industrial progress in India.

Nuclear Chemistry–Chemistry of the Future*

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Chemical changes have been interpreted in terms of atoms since the time when Dalton formulated his atomic theory. These atoms have served as the building-stones of the wonderful and variegated structure of chemical science, and the chemistry that has been evolved is, really speaking, the chemistry of atoms. It deals with the nature and behaviour of atoms of different types, their mutual interaction, combination and metathesis. Daltonian concept of atoms regards the latter as hard, indivisible particles of matter, having characteristic unalterable weights and forming the units of chemical combination. Development of atomic chemistry was supposed to set at rest once for all the probability of any transmutation of elements, which agitated the minds of alchemists previous to Dalton's time. But no satisfactory explanation could be given for a long time as to "why and how" these impenetrable and indivisible atoms combine to give rise to variety of molecules.

The Daltonian concept was, however, subjected to repeated assaults as a result of the formulation of the Periodic Law, and the discovery of cathode, Rontgen and radioactive rays leading to the recognition of electron--the unit of negative electricity--as an ultimate constituent of material atoms. A new idea or model for the chemist's atom was soon developed by Rutherford and Bohr (1913). This model pictured the material atom as a complicated structure consisting of a positively charged nucleus surrounded by a number of electrons, equivalent to the net positive charge on the nucleus. These electrons are supposed to revolve round the nucleus in definite quantized orbits. The nucleus was believed to be made up of protons, held together by a number of cementing electrons. The net nuclear charge or the number of extra-nuclear electrons, what was proved by Moseley to be identical with the atomic number, defined the chemical and physical properties of the atom; and the nucleus was held to be responsible for the mass of the atom. Discovery of isotopes among radioactive elements and subsequently among the commoner elements by Aston lent support to this view. The electrons in the outermost level of the atomic shell were regarded as valency electrons, they alone being concerned in chemical changes. Based on these ideas a comprehensive theory of valency was developed by Kossel and Lewis, which is known as the Electronic Theory of Valency. This was further extended by London and Heitler on the basis of wave-machanics. In the light of these new ideas, chemical changes are interpreted now-a-days in terms of the valency electrons of the atom, and an answer to "why and how" the atoms combine is thus supplied. The transference or sharing of valency electrons between the two combining atoms, giving rise to electrovalency and covalency ***respectively***, represents two main types of chemical linkages; and the cause of chemical combination is ascribed to the presence of uncoupled or unbalanced electrons in the outermost shell of the atom. The Chemistry of the present day may, therefore, be regarded as Electronic Chemistry—a finer development of atomic chemistry of the nineteenth century.

As a consequence of phenomenal discoveries in physical science within the last few years, an entirely new orientation is likely to be introduced in the development of chemistry in near future both as regards its objective and methods. As already stated, chemistry

* From a lecture delivered before the Science Association, Benares Hindu University, in March 1935.

was atomic in the nineteenth century and has been rather electronic in the last two decades of the present century, dealing with metathesis or union of atoms, consequent on the transference or sharing of electrons. Transformation of atoms, or more accurately of their nuclei, was unknown or unattainable, except in the case of spontaneous disintegration of radio-elements. This revived the old alchemist's dream of atomic transmutation, as all material atoms could be regarded as compounds of protons and electrons. The possibility of such transmutation was actually demonstrated in 1922 by Rutherford when he succeeded in effecting an artificial transmutation of commoner elements or a breaking up of lighter atomic nuclei by bombardment of the latter with long range alpha-particles from Ra-C. The nuclei of elements like nitrogen, phosphorus, aluminium, etc. were found to undergo disruption under these conditions with the expulsion of protons. Alpha-particles were supposed to be absorbed by the bombarded nuclei leading to the synthesis of heavier elements. This provided a fresh glimpse into a new type of reactions—i.e. nuclear reactions leading not to metathesis, but to a metamorphosis of atoms.

Within the last two or three years a few other projectiles or fundamental particles have been discovered, and these have been found as much effective as alpha-particles in bringing about artificial transmutation.

In 1932, Curie-Joliot in Paris found that when Be-nucleus was bombarded by alpha-particles from polonium, a highly penetrating radiation was emitted. Chadwick showed conclusively that the radiation consisted of particles of mass unity and charge zero, to which the name ***neutron*** was given. It is represented by the symbol $_0n^1$.

In the same year, C. D. Anderson at Pasadena discovered the counterpart of electron, i. e. the unit of positive electricity and named it the ***positron***. Shortly afterwards the discovery was confirmed by Blacket in Cambridge. Positrons were subsequently found to be emitted by the passage of γ-rays through matter of high atomic weight, often accompanied by ordinary electrons. From a consideration of the energy balance, this has been regarded by Curie-Joliot and Blacket as due to the ***materialization of the radiation quantum*** γ,—a twin birth of material particles from the annihilation of energy quantum. The matter in this process of material birth seems to act only as a ***catalyser***.

Curie and Joliot have further observed that positrons are emitted when certain lighter elements like B, Be and Al are bombarded by α particles.

Ejection of various particles in transmutation by α bombardment is shown below :—

Table

Nucleus	Li	Be	B	N	F	Na	Mg	Al
Particles emitted	n,γ	n,γ	H,n	H	H,n	H,n	H,n	H,n
		$\dot{e}$ e	γ, $\dot{e}$		γ	γ	γ	γ, $\dot{e}$

n = neutron, H = proton, $\dot{e}$ = positron, e = electron.

This shows that the proton should no longer be regarded as the only residue of atomic ruins.

Some examples of typical transmutation by α-particles will now be given. The interaction between the bombarding α-particle and the atomic nuclei are really nuclear chemical reactions, leading to transmutation or metamorphosis of atoms. As in the equations of ordinary chemical reactions, the sum of the masses and of the charges on both sides of the equation must remain unaltered.

$$_4Be^9 + {_2He^4} = {_6C^{12}} + {_0n^1},$$
$$_5B^{10} + {_2He^4} = {_6C^{13}} + {_1H^1}$$
$$_5B^{11} + {_2He^4} = {_7N^{14}} + {_0n^1}.$$

Positrons have also been used as projectiles. But when passed through matter they give rise to secondary ***photons***, which appear to arise from the annihilation of positrons by collision with electrons—a process representing the birth of radiant energy from the annihilation of matter.

Important results have, however, been obtained from experiments on the passage of neutrons through matter. By inelastic collision with the atomic nuclei, they bring about many interesting transmutations, e.g.—

$${}_7N^{14} + {}_0n^1 = {}_5B^{11} + {}_2He^4.$$

This is the reverse process of α-bombardment of boron, as stated above.

From the foregoing considerations it may be concluded that neutron is a real constituent of all atomic nuclei, as was shown by Heisenberg. Assumption of the existence of the free positron or electron in the nucleus is unnecessary. All nuclei are made up of protons and neutrons, e. g. $He = 2H + 2n$.

In heavier nuclei, protons and neutrons may form stable groups of alpha-particles. In nuclei of high positive charges, there will be a spontaneous tendency for the ejection of protons and alpha particles, due to Coulomb repulsion. Exchange forces of attraction between neutrons and protons counteract this repulsion (Heisenberg). Hence in heavier nuclei there are more neutrons than protons for the sake of stability. This is in agreement with actual facts, since in heavier elements the atomic weight is always greater than twice the atomic number.

The variation of the magnitude $n - H$ with a constant value for H gives the range of atomic masses over which the isotopes of any particular element are to be found. This difference is a measure of relationship between atomic weight and atomic number. When $n = H$, at. wt. $= 2 \times$ at. number ; this is the case with the elements of the first two short periods of the Periodic System. Beyond ${}_{20}Ca^{40}$, atomic weight rises more quickly than the atomic number.

Another new particle, an isotope of hydrogen (heavy hydrogen) was discovered in 1933 by Urey, Brickwedde and Murphy. This is known as Deuterium or Diplogen—${}_1H^2$ or ${}_1D^2$. The ion is termed deuton or diplon. When used as a projectile for nucleus breaking, it has been found more effective than proton. Thus :—

$${}_5B^{10} + {}_1D^2 \text{ (accelarated)} = 3\ {}_2He^4.$$
$${}_3Li^7 + {}_1H^1 \quad \text{''} \quad = {}_2He^4 + {}_2He^4.$$
$${}_3Li^6 + {}_1D^2 \quad \text{''} \quad = {}_2He^4 + {}_2He^4.$$
$${}_3Li^7 + {}_1D^2 \quad \text{''} \quad = {}_2He^4 + {}_2He^4 + {}_0n^1.$$

We thus find that there are four different particles that may be employed as projectiles to bring about disruption or transformation of atomic nuclei. These are fast protons, alpha particles, neutrons and diplons.

Discovery of Induced Radioactivity

Curie and Joliot (1934) found that when Al-foil was bombarded by alpha particles, the emission of positrons continued even after the source of alpha particles was removed. Boron and magnesium acted in the same manner. In other words, the nuclei were rendered radioactive. The half-life periods of the activities were Al = 3¼ min., Mg = 2½ min. These results were speedily verified by several other investigators. Fermi and his co-workers have shown that neutrons, being uncharged, can readily reach the atomic nucleus through the outer electronic shell, as for it, the potential barrier is no bar, and bring about disruption of heavier nuclei. They have succeeded in converting almost all the elements through neutrons into radioactive nuclei with the exception of H, Li, C, N, O, and the heavier elements Os, Ru, Tl, Pb and Bi.

Some typical nuclear reactions in these *artificial* or *induced radioactivity* processes with alpha-particles are given below :

$${}_5B^{10} + {}_2He^4 = \underset{\text{active}}{{}_7N^{13}} + {}_0n^1 \longrightarrow {}_6C^{13} + \overset{+}{e}$$

$${}_{13}Al^{27} + {}_2He^4 = \underset{\text{active}}{{}_{15}P^{30}} + {}_0n^1 \longrightarrow {}_{14}Si^{30} + \overset{+}{e}$$

$$ {}_{12}\mathrm{Mg}^{24} + {}_{2}\mathrm{He}^{4} = \underset{\text{active}}{{}_{14}\mathrm{Si}^{27}} + {}_{0}n^{1} $$
$$ \searrow {}_{13}\mathrm{Al}^{27} + \overset{+}{e} $$

Or, generally,

$$ {}_{z}\mathrm{M}^{a} + {}_{2}\mathrm{He}^{4} = {}_{z+2}\mathrm{M}^{a+3} + {}_{0}n^{1} $$
$$ \searrow {}_{z+1}\mathrm{O}^{a+3} + \overset{+}{e} $$

$$ {}_{6}\mathrm{C}^{12} + {}_{1}\mathrm{D}^{2} = \underset{\text{active}}{{}_{7}\mathrm{N}^{13}} + {}_{0}n^{1} $$
$$ \searrow {}_{6}\mathrm{C}^{13} + \overset{+}{e} $$
$$ \nearrow $$
$$ {}_{6}\mathrm{C}^{12} + {}_{1}\mathrm{H}^{1} = \underset{\text{active}}{{}_{7}\mathrm{N}^{13}} $$

$$ {}_{13}\mathrm{Al}^{27} + {}_{0}n^{1} = \underset{\substack{\text{active}\\ T\,=\,1\ \text{day}}}{{}_{11}\mathrm{Na}^{24}} + {}_{2}\mathrm{He}^{4} $$
$$ \searrow {}_{12}\mathrm{Mg}^{24} + \overset{-}{e} $$

$$ {}_{13}\mathrm{Al}^{27} + {}_{0}n^{1} = \underset{\substack{\text{active}\\ T=12\ \text{min.}}}{{}_{12}\mathrm{Mg}^{27}} + {}_{1}\mathrm{H}^{1} $$
$$ \searrow {}_{13}\mathrm{Al}^{27} + e $$

Thus one and the same atomic nucleus can be built up by different processes; on the other hand, one and the same substance can, by different reactions, be transformed into totally different nuclei, e. g.:—

$$ {}_{12}\mathrm{Mg}^{25} + {}_{2}\mathrm{He}^{4} = {}_{13}\mathrm{Al}^{28} + {}_{1}\mathrm{H}^{1} \searrow $$

$$ {}_{14}\mathrm{Si}^{28} + {}_{0}n^{1} = {}_{13}\mathrm{Al}^{28} + {}_{1}\mathrm{H}^{1} \rightarrow {}_{14}\mathrm{Si}^{28} + \overset{-}{e} $$

$$ {}_{15}\mathrm{P}^{31} + {}_{0}n^{1} = {}_{13}\mathrm{Al}^{28} + {}_{2}\mathrm{He}^{4} \nearrow $$

$$ {}_{13}\mathrm{Al}^{27} + {}_{2}\mathrm{He}^{4} = \begin{cases} \nearrow {}_{14}\mathrm{Si}^{30} + {}_{1}\mathrm{H}^{1} \\ \searrow {}_{15}\mathrm{P}^{30} + {}_{0}n^{4} \end{cases} $$

$$ {}_{13}\mathrm{Al}^{27} + {}_{0}n^{1} = \begin{cases} \nearrow {}_{11}\mathrm{Na}^{24} + {}_{2}\mathrm{He}^{4} \\ \searrow {}_{12}\mathrm{Mg}^{27} + {}_{1}\mathrm{H}^{1} \end{cases} $$

What is more striking, Curie and Joliot, as well as Fermi, have been able to *chemically* identify many of the intermediate active products.

All nuclear reactions dealing with transmutations are based on the following exchanges (the absorption of the bombarding particle by nucleus with the emission of a new particle), which is in some cases reciprocated.

$$_2He^4 \rightleftharpoons {}_0n^1,\ {}_2He^4 \rightleftharpoons {}_1H^1,$$

$$_1D^2 \longrightarrow {}_2He^4,\ {}_1D^2 \longrightarrow {}_1H^1, \text{ and}$$

$$_1D^2$$

The process $_0n^1 \rightleftharpoons {}_1H^1$ has not been observed as yet.

In all artificial radioactive processes only $\overset{+}{e}$ or $\overset{-}{e}$ are given out, but no heavier particles like He, H or *n*. The ejection of $\overset{+}{e}$ or $\overset{-}{e}$ may be due to the following intranuclear changes as suggested by Meitner :—

$$H \longrightarrow n+\overset{+}{e} \text{ and } n \longrightarrow H+\overset{-}{e}.$$

We thus find that for characterisation of chemical elements it is necessary to define the atomic number—the nuclear charge, or the number of planetary electrons. All chemical processes are concerned with these electrons. For characterising atomic nucleus two constants, mass and the charge, are essential. It may, therefore, be assumed that the nucleus should consist of two types of elementry particles, one charged and the other uncharged. These are H and *n* (proton and neutron).

Artificial transmutation by He, H, *n* and D lead ultimately to the formation of atomic nuclei, which are stable and represented by isotopes already known from mass-spectrographic investigations. On the other hand, the intermediate radioactive nuclei do not correspond to any of the known isotopes of the element concerned. To about 200 atomic nuclei, known up to the present time, representing 92 elements of the Periodic System, come now to be added this new series of radioactive nuclei. This forms the beginning, so to say, of a new chemistry of atomic nuclei—the chemistry of the future—dealing with metamorphosis and transmutation of atoms, as distinct from their metathesis dealt with in Daltonian and modern chemistry.

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Safety of Electric Installations in India

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(Continued from the last issue)

The comparative frequency of fatal accidents at the French domestic supply of 110 volts resulted in a committee being formed by the Minister for Public Works to investigate the causes of deaths from electric shock and to suggest remedies. To reduce the number of deaths from electric shock the committee recommended, *inter alia*, "that all portable apparatus be supplied at 25 volts." For the life of a man no amount is too much if it can be saved. Those governments have done what is necessary and our government should be pointed out the facts and the methods, adopted in such foreign countries for safety.

The rapid improvement in the manufacture of converters and rectifiers has made possible the use of D. C. or rectified current. "The desirability of maintaining D. C. particularly in the densely populated areas of large towns is a fact which has been specially favoured during the last few years by the perfection of the mercury rectifiers."

(*The Electrical Times*, p. 740, 23rd April, 1931).

In reply to questions in the Bengal Council, the Hon'ble Sir J. A. Woodhead, Member in charge of the Commerce Department of Bengal states as follows :—

"(*a*) Three deaths from electric shocks have been reported from Ballyganj during the last three months—two on September 22, and one on September 23.

(*b*) Deaths occurred in 1922 –4 ; in 1930 *nil* ; in 1931 - 2.

(*c*) (*i*) The approval of Government to the supply of electricity by the A. C. system in the Ballyganj area was granted on the 18th November 1920, and the change to the new system took place in 1923.

(*ii*) The change was considered to be more economical to the producers, and the Government *were advised that the consumers would not suffer any loss.*"

Against the statement that "consumers would not suffer any loss" we find "Precautions (!!,) recommended for users of electricity." This notice has been printed by the Bengal Government Press in the latter part of 1933 and the beginning of 1934, the copies printed being 1,00,000. These "Precautions" are being distributed through the covers of the bills of the Electric Supply Corporation. In this notice the Government says :—

"It may not generally be realised that no less than 104 electrical accidents were reported in Bengal during the last 3 years, of which 26 resulted in death. Many fatal accidents occurred in residential premises due to inadequate or entire lack of maintenance of aerial lines or bare wires such as those used for supplying electricity, from main buildings or residences to gate-lights, cook-house, garages, cow or horse sheds, servants' rooms, etc. Accidents also occurred to men working on live lines or circuits."

The above is an admission of the real dangers involved in the use of A. C. system, since out of 101 serious accidents resultant deaths have been as high as 26. Is this not an appalling figure if it has taken place in the course of the last three years only ? Who will assess the value of the lives of so many of our countrymen, who have been marched out of this world before their time for no fault of theirs ? Who will say how many of the 78 surviving unfortunates have been suffering from a life-long agony of maimed nerves or paralysis, and thus passing their miserable existence ? Or has their merciless law

of forfeiture of the rebate been mitigated to any extent for them? Decidedly not.

Is the adviser immune or not responsible to any body in our country for so many deaths and accidents that occurred in our country while he knows full well that perhaps not a single one occurred during 25 years in Calcutta when 220 volt D. C. was used and when our countrymen were more ignorant about the mysterious electricity?

"In the course of the last 35 years during which the Calcutta public has been using the D. C. current, there has occurred scarcely any death due to 220 volts D. C., whereas it is as high as 26 deaths with A. C. and that too only in the course of the last three years." (*Com. Gazette* 1934).

During the period 1911 to 1921 Scott Ram reported only 6 deaths from contact with 250 volts D. C. or less (1 from shock, and 5 from burns), whereas during the same period he reported 150 cases of death from contact with 250 volts A. C. or less—a period when, in the main, alternating current systems were in common use.

Berlin in Germany uses 220 volts D. C.

37 out of 44 installations in the Argentine Republic, 220 volts D. C.

Out of 341 installations in U. K., 88 installations are pure A. C., 54 installations are D. C., and 205 D. C. and A. C. both.

"In the heart of the city of London business houses, numerous residential flats are being supplied with direct current at 100 volts."

(*The Electrical Times*, p. 35—11th January 1934).

In view of the fact that 21 fatal accidents occurred on circuits of 250 volts or less in factories and workshops during 1929 and 13 in 1930, the attitude of the Home Office authorities appears to be quite justified; and they have even gone to the length of persuading occupiers of coke ovens to adopt direct current at 220 volts where crane trolley wires may possibly be touched by the workmen's metal tools, thus greatly reducing the risk of serious accident.

Mr. T. C. Gilbert, writes in his *Artificial Earthing for Electrical Installation*, on page 1, as follows:—

"In the United Kingdom electrical accidents have been remarkably rare in the past, and this happy state of affairs has been due to, I think, three main reasons: (1) most supplies up to the present have been direct current, (2) electricity has been employed mainly for lighting and power-driven machinery, and (3) extensions into rural areas have been small and are comparatively recent."

Plea of economy urged against 110 volts D. C.—"The cost of taking supply at 100 volts D. C., which, after all, ***might be the only sure way of eliminating deaths from electric shock***, would be prohibitive, even if from an engineering view-point it were possible." (I. E. T.).

For the life of a man no amount is too much if it can be saved -no question of economy would stand against systematic man-slaughter. Those governments have done what is necessary and our government should be pointed out the methods adopted in such foreign countries for safety instead of uttering baseless opinions and pass them as expert views in their anxiety to support the supply companies and the capitalists.

With regard to this plea for economy, it may be submitted that humanity will blush to the white of its eye to see the safety of innocent lives sacrificed in the sacred name of economy. Here it may be well to analyse the beneficiary of the economical undertaking and the man who gets the death shock. As to this, there is a vast difference between India and the foreign countries.

In England and foreign countries:—

(*a*) The charge to private, public and bulk supply is scarcely twice the cost of production and, therefore, the public enjoys the benefit of the undertakings.

(*b*) The supply company profit is limited by law (*vide* E. &. S., *the law relating to Electricity*, by C. M. Knowles. p. 28).

(*c*) Surplus profits go to ameliorate the public works and institutions.

(*d*) Municipal undertakings directly benefit the public.

(*e*) The employees are exclusively the sons of the land and thus they solve the question of unemployment of technical men to a great extent.

In India the case is different. The poor passers-by who touch the post and die, neither share the exorbitant profit nor get any benefit, and their relations get no compensation ; whereas, the electrocution of a horse caused the loss of a good consumer to the supply undertaking concerned, together with an award of damages against them in England (P. 22, Artificial Earthing for Electric Installations.) The Enterpreneur and the supply companies absorb the entire profit 10 to 25 times the cost of production —an unconscionable bargain ! Is it making a fairy tale of an expectation that the supply companies in India making such exorbitant charge should relegate a part of their profit, practically an insignificant amount, for the safety of the public, which the German and the French governments have made compulsory ?

We find that the French and German Governments have adopted voltage lower than 110 where necessary, and the Home Government is particularly perturbed regarding the use of 400-230 and a pressure of 50 has been suggested with the centre point of the secondary winding earthed, which will prevent any possibility of shock at more than 25 volts to earth. These Governments, unlike the supply companies in India, do not consider economy in saving pound, shilling and pence, but are anxious to heal old sores, remove bitter memories, strengthen old ties and renew a greater mutual confidence and good will. They consider that the highest economy is secured by a government when there is a safe, healthy and satisfied public, the real wealth of a nation.

Kouwhenhoven and Langworthy found that the sensation produced by an alternating current of 18-20 milli-amperes is painful and currents of 80-100 milli-amperes are dangerous and may cause death.

Investigation of many accidents showed that although a normal human being may withstand currents of 18 to 35 milli-amperes, yet these figures doubled may be dangerous, and it appears that currents of 80 to 150 milli-amperes are always fatal. Many factors govern the intensity of the current traversing the victim's body, as, although the resistance of the human body remains fairly constant at about 500 ohms, yet the contact resistance between the skin and the live medium may vary enormously. A man in a state of perspiration offers a superficial conductivity which will cause the current to keep close to the skin, whereas if his skin is dry and he has his feet on wet soil with his hands making a good grip contact with the live medium, then a grave risk is run. Sometimes a very heavy current burns a man to death (*vide* Scott Ram on 220 volts D. C., p. 4).

Dry skin on the palm of the hand has a resistance of from 40,000 to 100,000 ohms per. sq. cm., whereas with moisture present, the same resistance may fall to 1,200 ohms or less per sq. cm. (I. E. Times, p. 20).

Now imagine the perspiration in our tropical climate ! The hand and body are continuously perspiring and consequently the contact resistance being very low, the chance of electrocution is considerably increased. This partly explains why in a cold climate, like that of England, there are fewer accidents. Blood is a very good conductor ; cutaneous tissue having blood vessel is a good conductor.

Now let us examine some remedies suggested by so-called experts to avoid electrocution.

They believe that it is possible to reduce the number of deaths from electric shock by educating the public on common sense precautions. And as a large number of accidents have occurred through bad workmanship and interference with installations, owners of installations and users of electricity should be warned not to allow any one to interfere with an installation and as regards medium and large-sized installations, new work and alteration to existing installations should be carried out only under the supervision of a consulting engineer, and by a competent contractor in the case of additions or alterations to small installations.

(What about posts and walls which have caused so many deaths ?)

"The licensing board should make it its business to withdraw as quickly as possible, and without any other consideration than public safety, the license of any contractor or electrician found incapable of appreciating the significance of Ohm's law and, who, through bad training and lack of experience, is incapable of carrying out simple engineering work in a satisfactory manner ; and

(Do the authorities know how to make an installation safe ? If so, what instructions have they given for this purpose ?)

"The setting up of an approved body to examine, test and approve or reject all electrical apparatus intended for sale and for connection to any electric installation. I think this can be done without placing any considerable economic burden on the community."

To the Electrical Adviser and Chief Electrical Inspector to the Government of Bengal, the introduction of Rule 40 (A) of the Indian Electricity Rules is the panacea of all evils. And what does this rule enact ? It merely provides that "no electrical installation work, including additions, alterations, repairs, etc., shall be carried out upon the premises on behalf of any consumer—except by a duly licensed electrical contractor and under the direct supervision of a person holding a certificate of competency issued by the Local Government.

Failing to persuade the Government to observe Rule 40 (A) in the majority of cases of fatal accidents when breaches of the Indian Electricity Acts "and Rules have been discovered, the remedy is pointed" to be, "that persons responsible have been prosecuted," and that "in all cases conviction with fines or warnings has resulted."

Far from paying any heed to the fact that the 220 volts A. C. means 325 maximum voltage, and the dangerous nature of the same in case of accidental contact, the Chief Electrical Inspector and Electrical Adviser armed with unrestricted and unlimited Governmental powers conferred upon him by Sec. 55 of the Indian Electricity Act, acquiesces in the use of same everywhere, presumably to protect the bigger vested interests from the remotest chance of being forced to revert to the old system of D. C. or low volts A. C.

To me the advice of the Electrical Inspector sounds like that of one advising a drowning man to save himself by rallies of swimming, floating, holding on to straws and bubbles, but refusing steadfastly in spite of the proximity of a ladder to help him with, to clamber out of the water for good and all.

It being on actual record that "482 insulators, coming into regular use in May, 1909, supplied by a well-known English firm of insulator manufacturers, were broken between September, 1909, to June, 1911. (Mussoori, Hydro-Electric Scheme Completion Report, p. 28, Vol. 1). How could "any certificate of contractors" or any "punishment for anybody," save the lives that "were lost by touching the posts carrying 220 volts A. C. due to cracked insulator when we see, that "on August 21, 1910, 54 insulators broke down in one day in the small installation at Mussoori ?" Not withstanding all these voluminous evidences of real danger involved, "not to speak of various other inconveniences which the consumers have to suffer," the Electrical Adviser makes with supreme indifference the astounding statement in his report that the causes leading to any of the fatal accidents were in themselves not important; but had the Indian Electricity Rules been observed, most of the fatalities could have been prevented. And the remedy he chose for this was to launch prosecutions, resulting in convictions and fines, etc.

After having reviewed the above opinions, we see that transformation to lower voltage preferably to ***110 volts D. C. is the safest and ultimately the most ecnomical method for use all over the world.*** It will however be admitted that transformation to lower A. C. voltages can be economically utilised for domestic purposes such as lighting and small-power work. Those who are interested in heavier appliances may keep the whole show under constant expert supervision in case of A. C. supply.

Book Review

Text Book of Electricity and Magnetism (for beginners).—*By Krishna Pada Ghosh, M. Sc. pp. 386*+xx. *The Indian Press Ltd , Allahabad, 1933.*

Mr. Ghosh's book is meant for that class of students who have completed their school career. There are already a large number of books in the market, meant to satisfy the demands of these beginners in science. But in view of the rapid advancement in Physical Science one would be justified in bringing out a new book, incorporating ideas of modern physics.

Mr. Ghosh has evidently realised this. He has introduced elementary ideas about the structure of atom and the electronic theory of matter and has tried to treat the subject-matter in the light of modern discoveries in Physics. Recent conceptions of ferromagnetism, paramagnetism, diamagnetism and the magneton have found a place. Besides elementary ideas of X-rays, Cathode rays and radioactivity, nuclear structure, wireless telegraphy and television have been introduced in an instructive way.

The book deals with the present day applications of physical science in a more thorough manner than is customary, and the detailed treatment of electric telegraphy, electrothermic phenomenon, motors and dynamos, photoelectric cells, wireless telegraphy and television is a welcome change. Attempt has also been made to give a clear idea of the electric instruments like ammeters, voltmeters, galvanometers, platinum resistance thermometers, pyrometers, wattmeters etc.

The nonconventional way of inserting the chapter on magnetism between the chapters of voltaic electricity and electromagnetism, does not, on the whole, give us any advantage.

The get up and printing of the book have been thoroughly satisfactory.

A. D.

The Anatomy of the Salamander.—*By Dr. Eric T. B. Francis. With a Historical Introduction by Professor F. J. Cole. pp. xxxi+381+25 plates. (Oxford, at the Clarendon Press, 1934). 25s. net.*

Teachers and advanced students of Amphibia will congratulate Dr. Francis on the publication of this useful book of urodelan anatomy. The work, as is set out in the author's preface, aims at providing a gross anatomy and morphology of the common spotted salamander (*Salamandra salamandra* Linn.), after the fashion of Ecker and Gaupp's *Anatomie des Frosches*. The author says that histology and embryology are excluded, but one notes with profit that he has made use of many new and recent facts resulting from embryological studies which contribute much to the understanding of the detailed structural plan of the animal. The book begins with a general historical introduction by Professor F. J. Cole. Dr. Francis divides his book into 11 sections, and each section or subsection is prefaced by a useful summary of existing knowledge, followed by elaborate descriptions of organs concerned, in which recent and adequate nomenclature of structures is used. A characteristic feature of this book is that after each section a reference list is given in numerical numbers which refer to the general bibliography appended at the end of the book. This has saved much space and repetition of the same references over and over again after many sections. The bibliography comprises 38 pages with a long list of 804 titles of papers. The index is very useful in that it refers not only to structures but also to names of authors, to which due reference has been made. The book contains 25 plates with nearly 80 original figures drawn by the author himself, and a coloured frontispiece. Only this is to be regretted, however, that one has to turn pages (367-376) now and then for the explanation of the abbreviations

used in the figures. The book, which is evidently the result of much labour on the part of the author will serve as a very useful storehouse of facts and a clearly arranged work of reference for future investigators.

J. L. B.

A Manual of Practical Inorganic Chemistry.—*By Dr. E. H. Riesenfeld, University of Berlin, translated by P. Ray, M. A., University College of Science, Calcutta. Published by Chuckervertty Chatterji & Co. Ltd., College Square, Calcutta. Price 9s net. (Rs 6/-).*

The translator is to be congratulated on this excellent English version of Prof. Riesenfeld's well-known text-book. The book should be possessed and consulted by every student of chemistry in his college class. It contains a wealth of material, which is seldom to be found in any other English book of its nature. Besides a comprehensive account of the methods of qualitative analysis and separation, fundamental theories and principles of chemistry have been fully dealt with, and complete directions for the preparation of a number of important inorganic substances have been added. The book will be a welcome addition to every college library. Both as a laboratory guide and as a supplement to theoretical text-books in inorganic chemistry, the present book cannot be too strongly recommended. The teacher and the taught will be equally profited by it.

The book is neatly bound and well printed on good paper.

A. M.

Archaeology in Gwalior—*By M. B. Garde B. A., Superintendent of Archaeology, Gwalior State. pp. 151. With plates and a map. Second Edition, 1934. Price Re. 1-8-0.*

The regions now belonging to the State of Gwalior are of great interest to antiquarians. Some of the most celebrated cities of ancient India, *e. g.* Ujjayini, Vidisa and Padmavati, were situated here, and there are some other places of great archaeological importance, such as Mandasaur, Bagh and Udayagiri. Gwalior has also yielded some inscriptions of great palaeographical and historical value, for instance the Besnagar inscription of Heliodoros which describes the conversion of a Taxilian Greek to Vaishnavism, the Mandasaur inscriptions of Bandhuvarman and Yashodharman, dealing with the rout of the Huna Mihirakula, the much spoken-of but still unpublished Tumain inscription of Ghatotkacha-Gupta, and the Sagar-tal inscription of the Pratiharas. It is right therefore that the State should have an energetic Archaeological Department and a Museum of its own. This is all the more commendable as some, leading states apart, the native states are usually apathetic to archaeological relics under their respective trusts.

The present book contains brief accounts of the Gwalior monuments, inscriptions and coins. There is a section dealing with the excavations already carried out by the Department. We must add, however, that much is still left to be desired in this direction. The second part of the book contains more or less detailed descriptions of all the important archaeological sites within the State.

The book will no doubt prove to be of use to Indologists. The plates are well-printed.

A. Ghosh.

Elements of Optics. (for beginners)—*By Krishnapada Ghose M. Sc., lecturer in physics, Scottish Church College, Calcutta. Published by the Indian Press Ltd., Allahabad. (1934) pp. 262 Price. Rs. 2/8/-.*

The book which is the result of experience, as the author says, in teaching the principles of optics for many years is intended to serve as the basis of a first course for students of intermediate classes of all Indian universities.

Beginning with a discussion on the general concepts of optics, which includes a lucid elementary account of wave motion, the author passes on to the rectilinear propagation of light. Then the phenomena of reflection and refraction are discussed in detail both for the

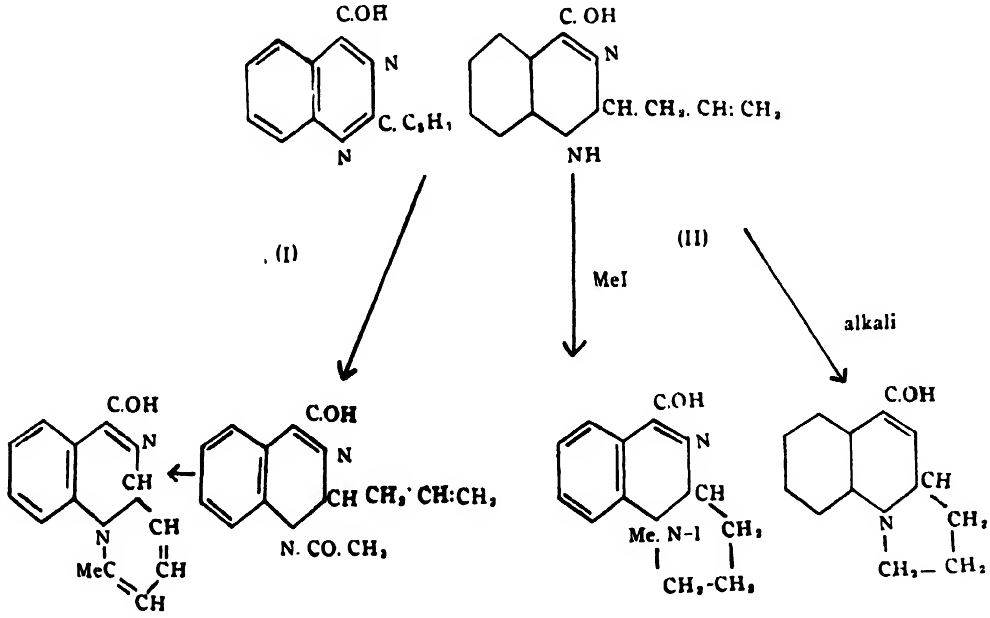
cases of plane and spherical surfaces. The next two chapters on optical instruments deal with all the well known instruments including the natural one *i. e.* the human eye. The remaining chapters are on dispersion, spectroscopy, photometry and the velocity of light, of which the first two are particularly interesting and up to date; but the reviewer hopes that in the next edition the chapter on photometry will include the description of one or two modern instruments, and a short description of Michelson's experiments will be added to the chapter on the velocity of light.

In going through the book the reviewer is delighted to find that the author has not followed the conventional track of almost all the junior text books, which devides the subject of optics into two rigidly separated parts of geometrical and physical optics. And with a view to present a more unified treatment he has introduced the idea of waves as applied to the subject of optics from the beginning. He is quite right when he says that the idea of wave motion lies at the bottom of everything else and therefore even the junior students should be taught in such a way that their ideas on the subject should develop strongly associated with the notion of frequencies, waves and if possible with groups. Another new and valuable feature of the book is that it includes simple aspects of Spectroscopy, Quantum theory Atomic Physics, Relativity and the applications of the principles of optics to Astrophysics. All these have made the book one of the best and most up to date of its class. An important omission to which the reviewer would like to draw attention is the phenomenon of rainbows.

The reviewer could not find any "contents" of the book received by him, though there is an index of five pages at the end. The get up and printing are satisfactory.

Vasicine and Peganine

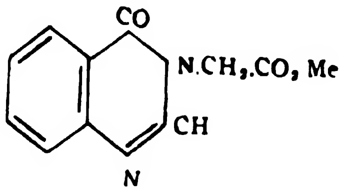
Vasicine, $C_{11}H_{12}ON_2$, m. p. 196° (decomp.), was isolated from the leaves of *Adhatoda vasica, Nees* (N. O. Acanthaceae) by Sen and Ghosh (*J. Indian Chem. Soc.*, 1925, *1*, 315). Further investigations by Ghosh (*J. Indian Chem. Soc.*, 1927, *4*, 1) proved the presence of a quinazoline ring in the molecule. It could be oxidised by alkaline permanganate solution to 4-oxyquinazoline; fusion with potassium hydroxide furnished anthranilic acid. With phosphorous pentachloride vasicine gave chlorodesoxyvasicine, which on reduction with zinc dust and hydrochloric acid gave desoxyvasicine, $C_{11}H_{12}N_2.\frac{1}{2}H_2O$, m. p. 87-88°. It was therefore formulated as 3-propyl-4-oxyquinazoline (I). A compound of this structure was synthesised by De and Rây (*J. Indian Chem. Soc.*, *4*,541) by condensing *n*-butyranilide and *iso*butyranilide with urethane, but the synthetic products were found to be different from vasicine.



Ghosh, Krishna, Narang and Rây (*J. Chem. Soc.*, 1932, 2740) confirmed the findings of Ghosh (*loc. cit.*) and found moreover that vasicine could be transformed into an isomeric compound (III), *iso*vasicine, m. p. 164°, by a trace of alkali. Vasicine and *iso*vasicine gave the same methiodide (IV). Vasicine further possessed weak phenolic properties and on acetylation gave an acetyl derivative (V) containing one molecule of water less than the normal acetylation product. These reactions were explained by assuming a structure (II) for vasicine. Robinson (*Ann. Rev. Biochem.*, 1933, p. 421) however did not find the arguments convincing.

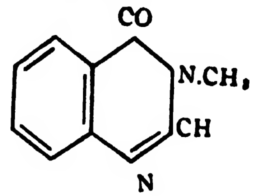
In 1934 Späth and Nikawitz (*Ber.*, 1934, *67*,45) published their investigations on the constitution of a base called peganine, which was obtained from the mother-liquor of the alkaloids of *Peganum harmala* (N. O. Rutaceae). It possessed the same molecular formula as vasicine but a higher melting point. Peganine was found to contain *one* 'active' hydrogen atom. By oxidation with alkaline permanganate followed by esterification with diazomethane they ob-

tained methyl 4-keto-3 : 4-dihydroquinazolyl-3-acetate (VI) which was further degraded to 3-methyl-4-keto-3 : 4-dihydroquinazoline (VII),



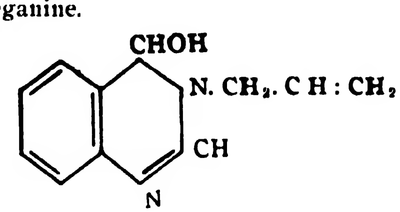
(VI)

and to anthranilic acid and glycine. On reduction with sodium and amyl alcohol peganine gave dihydrodesoxypeganine, $C_{11}H_{14}N_2$ De-



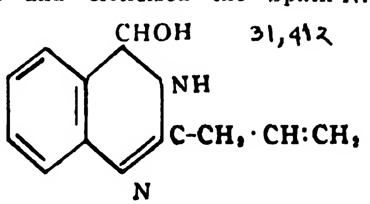
(VII)

oxytetrahydropeganine) and on reduction with tin and hydrochloric acid, tetrahydrodesoxypeganine, $C_{11}H_{16}N_2$ (deoxyhexahydropeganine). Späth and Nikawitz discussed several possible formulas for peganine but gave peference to (VIII) without furnisliing adequate proof of the the presence of an allyl group in the molecule. Peganine showed some points of similarity with vasicine, but the possibility of the two alkaloids being identical was at this stage left open, mainly because peganine gave a normal acetyl derivative different from the product formulated as (V) and it could not, like vasicine, be isomerised to *iso*peganine.



(VIII)

Narang and Rây (*Current Science*, 1934, *2*, 388) suggested that the two bases might be different and criticised the Späth-Nikawitz formula for peganine on the basis of the evidence at hand. Späth and Kuffner (*Ber.*, 1934, *67*, 868) however definitely established the identity of the two alkaloids by comparing them and a number of their derivatives. Later on they synthesised the ester (VI) and found it to be identical with the degradation product of peganine (*Ber.*, 1934, *67*, 1494). Reynolds and Robinson (*Nature*, 1934, *134*, 142) also regarded the Späth-Nikawitz formula as unsatisfactory. Being a carbinol base peganine should have formed a hydrochloride of the type $B,HCl-H_2O$ but it gave a normal salt of the type B,HCl. They moreover synthesised the compound (VIII) by treating the quaternary salt, obtained from quinazoline and allyl iodide, with alkali and showed it to be different from peganine or vasicine. Narang and Rây (*Chem. and Ind.*, 1934, *53*, 698) then proposed a new formula for vasicine (IX). This is also of the carbinol base type and apparently contains *two* 'active' hydrogen atoms in the molecule. They attempted to explain the formation of (VI) by assuming the formation of an intermediate compound of the type (X). They further pointed out that desoxyvasicine was not identical with 3-allyl-3: 4-dihydroquinazoline. If the formula (VIII) had



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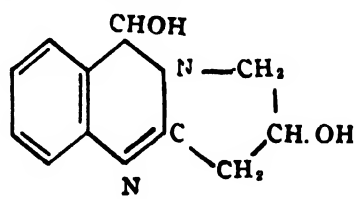
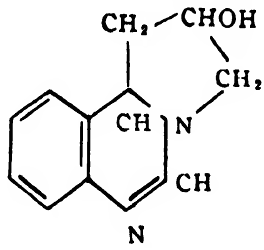


(X)

been correct, then the two substances should have been indentical. Hanford, Liang and Adams

(*J. Amer. Chem. Soc.*, 1934, *56*, 2780) then showed that vasicine did not possess weak acidic properties. Moreover the allyl groups of 3-ally-3:4-dihydroquinazoline and of 3-ally-4-keto-3:4-dihydroquinazoline could be catalytically reduced whereas vasicine and desoxyvasicine are resistant to catalytic hydrogenation. Thus they furnished some proof of the absence of an allyl group in vasicine and peganine. These authors preferred the cyclic formula (XII). The above two formulas (XI) and (XII) were first proposed by Späth and Nikawitz and supported by Reynolds



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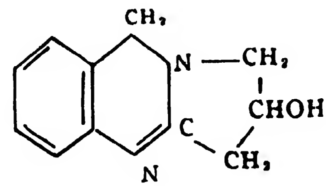
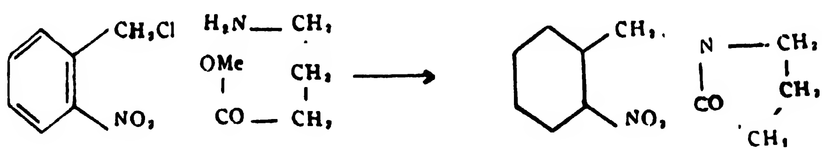


(XII)

and Robinson (*loc. cit.*). Confirmations of the presence of such a ring structure in peganine was made by Späth, Kuffner and Platzer (*Ber.*, 1935, *68*, 497) who were able to synthesise desoxypeganine (XII) and dihydrodesoxypeganine (XIII) as follows: o-Nitrobenzylchloride was condensed with methyl 4-aminobutyrate and the pyrrolidone (XIII) thus obtained was reduced by stannous chloride and the amine (XIV) treated with phosphorous oxychloride when (XV) was obtained. On reduction with sodium and ethyl alcohol (XV) gave (XVI). These bases were found to be identical with desoxypeganine (from chlorodesoxypeganine) and dihydrodesoxypeganine (from peganine, sodium and amyl alcohol) respectively.

Following an identical process, but using methyl 1-hydroxy-4-aminobutyrate in place of methyl 4-



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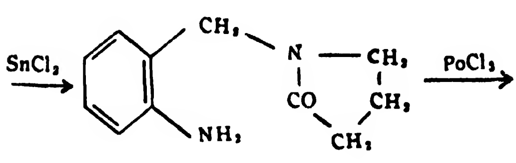

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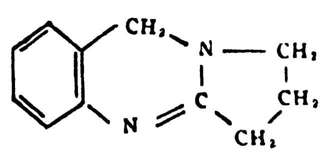
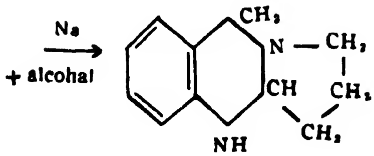
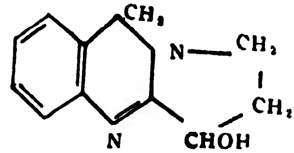


(XV)



(XVI)



(XVII)

aminobutyrate, they finally obtained a base (XVII), m.p. 211-12°, indentical with vasicine (peganine).

Roentgen Ray Therapy

Subodh Mitra, M. D., F. R. C. S.

Discoveries are but sideway realisations to the great seekers of Truth. This happened in Conrad Roentgen's life in 1895; while deeply engrossed in other experimental research works, Roentgen accidentally discovered X-rays. Since the discovery, Roentgen Rays were at first empirically rather indiscriminately used in almost every case of skin-disease. In 1897, Kummell reported the successful treatment of Lupus Vulgaris with X-rays in the Deutsche Chirurgische Gessellschaft; and in the same year Ziemassen spoke in a Medical Association in Munich (Germany) that inoperable Carcinoma cases could be better tackled with X-rays without having any deliterious effect upon the patient.

The real Roentgen-therapy era began at the beginning of the 20th century when Perthes first measured the intensity of Roentgen Rays by means of Barium-Platino-cyanide, and Sabour and Noire by Pastiles made of the same substance. The very satisfactory and accurate measurement of Roentgen-rays was first done by Becquerel by means of Ionisation of air. It was with Becquerel's Electroscope that M. and Mme. Curie found substantial help in discovering Radium. The latest method is to estimate the electrostatic R units as introduced from Physikalisch-Technische Reichanstalt of Berlin. Now these R-units have been taken up by all the radiologists of the world, and with certain modifications have been recognised as the "international r-unit".

The most important and at the same time most difficult problem in the whole of Roentgen-therapy is the estimation of a correct dose. It is important because on it depends the therapeutic value, and it is difficult because there is no fixed Roentgen Dose. It is mostly influenced by the personal equation of the Roentgenotherapist who judges each case on its own merit.

To give a general idea, the Roentgen Dose may be defined as follows: when X-rays fall upon a surface they get absorbed through the body; and only a definite part of it acts biologically. This part of absorbed energy which is biologically effective, multiplied by time, is known as Dose.

The Roentgen Dose is generally divided into

A. Physical Dose, and

B. Biological Dose.

A. Physical Dose.

It depends on the intensity of radiation and its power of penetration. If E_1 is the surface energy and E_2 energy of X-ray bundle, unabsorbed on the undersurface of the object having the volume V, then the ***Physical Dose*** would be

$$D = \frac{E_1 - E_2}{V}$$

This Dose is only an average one, as the upper layer of the object receives a greater dose than the lowermost layer because of absorption and dispersion.

If the volume of the object traversed by X-ray bundle be such that it reduces the intensity of radiation to half its value then the intensity of lower surface is just half the intensity of the upper surface and the dose may be half the surface energy divided by volume.

Thus the Physical Dose may be estimated from the energy incident on the surface and half-value-layer of the X-ray bundle. The half-value-layer again depends on the absorption co-efficient of the absorbing medium for the particular radiation. The absorption coefficient of an object irradiated can be easily determined from the well-known absorption law.

Proceeding on these ideas, we can easily calculate mathematically the Physical Dose in terms of known quantities.

$$D = \frac{n h \nu}{4\pi r^2 d}\left(1 - e^{-\mu d}\right) + f(s)$$

where μ is the absorption coefficient, "d" is the

distance traversed by X-ray bundle, "h", "n', "ν", have their usual meanings, f (s) denotes the scatterring factor.

The dose is proportional to the intensity entering the volume, inversely proportional to the half-value-layer and directly proportional to the absorption coefficient.

B. ***Biological Dose.*** (Skin Erythema Dose)

The Biological Dose is determined by the reaction of the skin, which appears and disappears within a certain length of time. It is arbitrary and has got a varying clinical estimation. It depends to a certain extent upon the observation and personal equation of the specialist worker.

According to ***Seitz*** and ***Wintz***, the Erythema Dose is the highest amount of X-ray radiation, which the skin can tolerate without any damage. There is a slight reddening of skin after 8 days; light brown coloration after 3 weeks and a deep brown pigmentation after 6 weeks. ***Wintz's*** subsequent experiment is expressed by Rump in the following generalisation: Skin—Erythema Dose is a physical measurement which has been fixed by observation of 1000 cases in Erlangen clinic and is thus taken as a standard of the Biological Dose. Skin-Erythema Dose is constant although skin reaction varies according to Biological reaction and individual variation.

Holfelder estimated the Biological Dose by capillary microscope. Erythema Dose according to him is not at all used as a standard. It is possible to get pigmentation even with 20% of the full Skin-Erythema-Dose.

Sielman's Dose : Slight Erythema after 8 days; light yellow pigmentation after 3 weeks and deep pigmentation after 6 to 8 weeks.

We have tried to make a standard by Biological changes on the Indian skin—"Sevasadan standard": Skin-Erythema-Dose is one that causes reddening of skin with raising of hair papillae within 3 or 4 days after radiation. This slight erythematous condition turns into bronzing the skin within 8 or 10 days, and ultimately leads to deep pigmentation within 6 weeks.

Observation by Kuestner's Gauzing Apparatus:

It has been possible by this apparatus to bring the Physical Dose nearer to perfection and one can safely depend upon it as much as on the Biological Dose which is estimated by means of erythema and pigmentation. A minute dose is measured in "R" per unit.

$$D = K.\frac{\text{Radium seconds}}{\text{Roentgen seconds}} \text{ R minute,}$$

where K is Kuestner's constant with reference to Radium constant of the apparatus.

Measurements have been done by us under the following conditions :

(1) Roentgen Apparatus....Stabilivol (Tropical)
(2) Current through "Ventil" tubes....6. 5 Amps.
(3) Current through therapy tubes....4 M.A.
(4) Filters....0. 5 mm. Cu and 1 mm. Al.
(5) Effective Voltage......180 K. V.
(6) Distance between the tube and lead partition wall (4½") is 95½", and between the latter and the apparatus 40".

Experiment.

Tube no. 1.

Radium Seconds......20.9 (mean value) (Reading in the electrometer scale has been taken between 10 and 30 scale division and spontaneous discharge was nil).

Roentgen seconds........38 (mean value). From Kuestner's scale,

Dose = 24 R per minute, Skin-target-distance being 30 cm., and portal of entry 10 × 15 cm.

Biological Dose has been estimated as follows :

(Seva Sadan Standard)

Patient's name........G. B.
Date of experiment....28. 6. 29.
Therapy tube......... no. 1.
Filters................O. 5 mm. Cu. & 1 mm. Al.
Effective Voltage......180 K. V.
Skin Target Distance...30 cm.
Portal of entry........ 10 × 15 cm.
Time of exposure......25 minutes.

Following up :

1. 7. 29...........	No reaction,
2. 7. 29...........	Reddening of skin.
4. 7. 29...........	Pigmentation.
8. 7. 29...........	Pigmentation+
11. 7. 29..........	Pigmentation+
8. 8. 29..........	Pigmentation++

Thus according to Kuestner, the full Skin-Erythema-Dose is expressed as 25 × 24 R or 600 R or 639r. (R=1.066r).

We have observed the Biological Dose in over 100 cases in the Seva Sadan and from those data we find that our Skin-Erythema-Dose varies between 480 R and 663 R having a mean value 571 R. The different standards are as follows :

Sielmann	(Munich).......	400 R—550 R.
Holthusen	(Hamburg)....	450 R—630 R.
Rump.....................		480 R—600 R.
Holfelder	(Frankfurt).....	500 R—560 R.
Behreus	(Gottingen).....	540 R—580 R.
Sanpe	(Dresden)........	500 R—600 R.
Harms	(Hannover)......	600 R—659 R,
Seva Sadan	(Calcutta)........	480 R—663 R.

After a careful study of Skin-Erythema-Dose in R—units of different workers, Kuestner finds out the average 551 ± 15% or to put in round numbers *550 R*. Our estimation of the Erythema Dose (571 R) is slightly higher than the average, which might be due to tropical climate.

Our Garden Sansevierias.

K. Biswas, M. A.

Curator of the Herbarium, Royal Botanic Garden, Calcutta.

Out of about sixty species of Sansevierias only four species may be considered indigenous to the Indian Empire. These are *S. Roxburghiana* Schultes, *S. lanuginosa* Willd, *S. zeylanica* Willd and *S. burmanica* N E. Brown. Of these four species *S. Roxburghiana* is the most common, occurring along the coast of Coromondal, Lower Bengal, Orissa and Chota Nagpur. The specific rank of *S. lanuginosa* has, however, been doubted, I think rightly, by N. E. Brown. The most stable species of India proper is the widely distributed *S. Roxburghiana.*

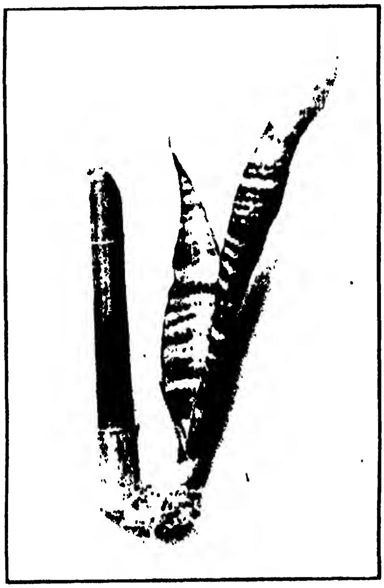
No. 1.

Sansevieria nilotica, Var. Laurentii, showing the yellow strips along the margins of the leaves. ($\frac{1}{12}$)

The plants under the genus Sansevieria are mostly garden plants. The species at present generally growing in the gardens of India are *S. Roxburghiana*, *S. zeylanica* (Ceylon) and *S. burmanica* (inhabiting Upper Burma) within the range of the Indian Empire. The foreign species under cultivation are *S. guinensis*—evidently of Gerome, which is considered by Prain and Brown as synonymous to *S. trifaciata* of Prain (Tropical Africa), *S. cylindrica* (Tropical Africa), *S. nilotica* (Tropical Africa), *S. nilotica* var. *trifaciata* (Tropical Africa) and *S. nilotica* var. *Laurentii* (Tropical Africa). It is found

that many a foreign species has been established in this country for some years. Consequently, a few horticultural varieties and forms of these species have come into existence. Some of these varieties and forms have developed such definite morphological characters that they are not without reason considered horticultural species. Of these may be mentioned De Willdem's *S. Laurentii* and David Prain's *S. Trifaciata.* N. E. Brown in his illuminating monograph on "Sansevieria" recognised the specific rank of *S. trifaciata* (Hort) Prain. A detailed examination of fresh and herbarium specimens and literature available in this garden and library leads me to hold the opinion that there is hardly much specific difference in the botanical sense between *S. trifaciata* of Prain and *S. nilotica* of Baker, both of which are natives of tropical Africa. The former is reported to occur in Jalpaiguri, northern Bengal and subsequently grown in the Royal Botanic Garden as far back as 1879 onwards. This species, as Prain remarks bears close relationship to the West African Bowstring Hemp *S. guinensis.* The latter is a native of tropical Africa described by Baker in the year 1875. Both of these species *S. nilotica* Baker and *S. trifaciata* (Hort) Prain have been placed by Brown in his key under the same general characters of the leaves and differing mainly in dimensions of pedicels and other minor characters of floral parts which, however, seem to be rather overlapping. On the above grounds and as a result of scrutiny of authentic herbarium specimens and living plants grown in the garden the writer holds that *S. nilotica* of Baker is the stable species in the real botanical sense ; and *S. trifaciata* of Prain may be reduced to a variety of *S. nilotica* of Baker. This is evidently the reason why Prain remarked that the plant is a horticultural production. Another horticultural species closely allied to *S. nilotica* and *S. trifaciata* is Willdem's *S. Laurentii* named after M E. Laurent, and exhibited by Messrs. Sanders and Sons at the Temple Show of the Royal Horticultural Society in May 1909. This plant is at once distinguished from *S. nilotica* and *S. Trifaciata* by its having deep yellow 6-1.3 cm. or slightly more wide longitudinal stripes along the margins of the leaves. Brown therefore reduces *S. Laurentii* Willdem to the variety of *S. trifaciata* Prain. The writer basing his argument on the points mentioned before, advocates that both these horticultural species—*S. trifaciata* (Hort) Prain and *S. Laurentii* Willdem may better be taken as varieties of *S. nilotica* Baker. Thus reduced, the nomenclature is modified as follows : *S. nilotica* Baker—the species proper ; *S. nilotica* Baker, var. *trifaciata* (Prain) Biswas, synonym—*S. trifaciata* (Hort) Prain ; *S. nilotica* Baker, var. *Laurentii* (Willdem) N. E. Brown. Detailed descriptions and notes are available in Brown's monograph on Sansevieria and the author's paper entitled "Notes on the Systematic position of Sansevieria growing in India with special reference to S. Laurentii Willdem." His conclusions regarding the systematic position of *S. Laurentii* is further confirmed by a plant recently raised in the Royal Botanic Garden nursery from a cutting of a portion of the yellow stripped leaf which reverted to the typical species *S. nilotica* with the normal leaves without the trace of yellow stripes along the margin as illustrated in the photograph No. 2. This fact has already been explained by N. E. Brown in these lines: "The more recently introduced variety Laurentii is rather a remarkable plant, not so much on account of its beautifully variegated foliage, but because the variegation is not reproduced in plants raised from leaf cuttings. At least all efforts made at Kew to propagate the variegation from cuttings of the variegated leaves resulted in failure, as all the plants so raised have reverted to the typical form, without a trace of the yellow striping. Even plants that have originated directly from the yellow parts of a leaf cutting have no trace of the yellow in them, so that, it would appear, the power to reproduce the yellow variegation resides entirely in the root stock, as cuttings of the latter always reproduce the variegated plant". Not much attempt seems to have been made to raise this var. Laurentii from the leaf cuttings of the yellow striped leaves in India, although this can be done under not very exceptional circumstances as described here by Mr. N. Mitra. Curator, Royal Botanic Garden, Calcutta, with

the same result as achieved at Kew. Mr. Mitra, notes "The leaf was planted in ordinary mould of Bengal on 10th August, 1934, and plantlet has come up by the end of February, 1935. The leaf cutting was watered occasionally and was kept in the open. The plantlet does not seem at present to be Laurentii". This var. Laurentii is one of the magnificent ornamental Sansevieri-



No 2,

Plant raised from the leaf-cutting of the variegated leaf. The plant so raised has leaves without yellow stripes.

as, and of late profusely cultivated in various gardens in India both in the open and in the conservatories. The seeds and root stock of this variety Laurentii are available at the Royal Botanic Garden, Calcutta, from the Curator and from Dr. D. S. Laud of the Victoria Garden, Bombay. Dr. Laud informs me that he got this plant first introduced in Bombay gardens from Richmond Nurseries, England, in 1931. For this information my thanks are due to Dr. Laud.

Herbarium.
Royol Botanic Garden,
Calcutta, 10th. May, 1935.

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The Baluchistan Earthquake of 1931

It is noteworthy that about four years ago, Baluchistan was visited by a pair of rather severe earthquakes. These earthquakes were fully reported by Mr. W. D. West of the Geological survey of India (Vol. *67* 1934). In view of the recent disaster, a short account of this earthquake will probably prove to be of some interest.

The first earthquake which had its epicentre at Sharigh [30° 11′ N/67° 42½″E, henceforth called the Sharigh Earthquake], took place on Tuesday, Aug. 25, at 03 hr. 05 min. 27 sec. Indian Standard Time or 22 hr. 35 min. 27 sec. Greenwich Mean Time. The intensity was 8 on the Rossi-Forel Scale. The area affected was about 31,000 square miles. The shock appears to have been a shallow one, as its intensity rapidly diminished from the epicentre. There was considerable damage to buildings in the epicentral area, but little or no damage at some distance from it. The second earthquake had its epicentre at Mach [29°47½′N/67°16′E henceforth called Mach Earthquake] and took place at 20 hr. 57 min. 30 sec. I. S. T. or 15 hr. 27 min. 30 sec. G. M. T. This was more intense than the previous one, and was felt over an area of 370,000 square miles. The intensity at the epicentral region was slightly higher than eight, but the shock appears to have been a deepseated one. The shock lasted for over a minute. In all about 120 men were killed, and considerable damage was done to the areas in the epicentral region.

The papers report that during the recent earthquake, a mountain near Mastung has split in two, which they ascribe to the action of a dormant volcano. Such reports were in circulation during 1931 and the following quotation from Mr. W. D. West, M. A. (Cantab) Asst. Superintendent, Geological Survey of India, regarding the supposed volcanic origin of the Mach earthquake will be interesting :

"On the morning after the earthquake a low cloud was seen hanging over the hills to the north of Mach, and for five or six days loud reports were heard at intervals from that direction, frequently followed by the uprising of a cloud of 'smoke'. It was believed that the explosions were the manifestations of volcanic activity, and when the aeroplane reports came to hand stating that the ground in places was blackened, the idea received unexpected confirmation. So seriously was this believed and so widespread had the belief become, leading Quetta to suppose that it was situated on the edge of a volcano, that it seemed desirable to investigate the matter. In consequence, on September 6th accompanied by Capt. Colhoun, I paid a visit to the hills from whence the clouds of 'smoke' had arisen, to the N. N. E. of Mach. The explosions and the smoke were soon explained. They had clearly been due to the falls of limestone. For not only were the steep sides of the streams covered with land slides, but everywhere the place was covered with a thick mantle of white calcareous dust, derived clearly from the limestone as it collapsed. That this had only recently accumulated was clear from the fact that there had been heavy rain in this district, only a week before. Finally, the blackened ground noticed by the airmen was an outcrop of Tertiary coal, which has long been known to occur in these parts."

Mr. West made the following observations regarding the damage done to Quetta due to faulty house building :—

"In considering the effects of the earthquake upon Quetta , it is necessary to point out that the town of Quetta is divided into two parts by a stream known as the Habib *nala*, which runs in a W. N. W. direction. North of this *nala* is the Military Cantonment, while south of it is the civil station. Examination of the town as a whole soon revealed that the civil station had suffered more severely from the earthquake than the cantonment. To be correlated with this

rather sharp distinction, and possibly having some connection with it, is the fact that in the northern or cantonment half the ground is exceptionally dry, so much so that there are no water-bearing wells in that part of Quetta situated north of the Habib *nala*. On the other hand the civil station, to the south of this *nala*. is situated on water-bearing strata. Whether this distinction has any connection with the different degrees of severity with which the earthquake was felt, is a matter of speculation; but it is probably worth recording.

"In every case damage was only sustained by those buildings in the construction of which soft mud mortar had been used. Those buildings which had been constructed with an ordinary lime mortar were quite unaffected by the earthquake...But the majority of the better buildings in Quetta such as the residential Bungalows, the shops and similar large buildings, although built of burnt bricks, have only a soft mud mortar, a material which has practically no bonding power. Such buildings are naturally very susceptible to damage from earthquake shocks...But the fact that so few buildings, thus constructed, were at all damaged shows clearly how comparatively slight was the shock experienced at Quetta."

West gave a discussion on "the Earthquakes in relation to Building Methods" and made the following recommendations regarding the future building programme:

"As regards future building in Quetta, it is suggested that a stricter supervision be employed in the case of the better class buildings, as has been done in Japan, California, New Zealand and in other places subject to earthquakes. Such a badly constructed building as the Town Hall at Quetta should never have been put up in an area where earthquakes are not uncommon. As Quetta is an important military station, with a large population during part of the year, it should be the endeavour of the authorities to make it less susceptible to earthquake damage than it is at present. At present the majority of buildings at Quetta are about as unsoundly built, from an earthquake proof point of view, as it is possible for them to be. It is absolutely essential to discard the use of the mud mortar in buildings of more than one storey, and it would be advisable to do likewise in all buildings especially those which from time to time house a large number of people, such as halls, cinemas, clubs and so on."

The occurrence of earthquakes gives rise to so many superstitious ideas, that people are apt to forget the lessons, which they could have otherwise learnt, within a short time. In view of the persistence of theological ideas regarding the origin of earthquakes in this country repeated from time to time not only by pandits and Mollahs, but also by men like Mahatma Gandhi, it will probably be useful to quote the opinion of scientific men regarding the possibility of occurrence of earthquakes in India.

Count F. De Montessus de Ballore, in his Comprehensive Survey of the Seismic Phenomena in British India, and their connection with its Geology" (Memories of the Geological Survey of India, Vol 35/3) divides the earthquake-affected area of India in twelve sections, of which Afghanistan and Baluchistan form the first. He describes the area as follows :—

I. Afghanistan and Northern Baluchistan.
II. North-Western Himalayas (Kashmere, Kumaun.
III. Punjab.
IV. Upper India
V. Western India.
VI. Peninsula.
VII. Ceylon.
VIII. Eastern Himalayas, Assam and Lower Bengal.
IX. Arakan and Burma.
X. Malay Peninsula.
XI. Bay of Bengal.
XII. Indian Ocean.

The Earthquakes so far recorded in this area are :—

1852—1890. (*a*) The Kahan Earthquake (1852). This is the earliest earthquake of which reliable information is available. At 3-15 A.M. on the 24th January 1852, a very severe shock was felt in the Loralai district. It appears that 260 Mohammedans and 80 Hindus with a

large quantity of cattle and considerable loss of property, were killed. Another violent shock was experienced in the same district in 1865,

(*b*) In 1862 an earthquake disaster occurred in the Kohlu Village, when the villages of Karam Khan Shahr, Dada shahr, and Oriani were levelled to the ground.

(*c*) An earthquake shock was felt in the Kalat State at 3 P.M. on the 28th of October, 1870. It did no serious damage.

(*d*) In Jhalawan, a severe shock was felt in 1883, when houses at Toba and Alat were much damaged. Another earthquake occurred in Jhalawan in 1889 which almost wholly destroyed the village of Haji Ibrahim Khan Mengal in Wadi.

(*e*) An earthquake of slight intensity occurred at Mastung in 1884.

(*f*) In about 1890 earthquake shocks were unusually frequent in Sanjawi, In the Loralai district, where they are said to have occurred every two or three days for about a month.

1892—1903 (*a*) A severe earthquake which is on record took place on the morning of December 20, 1892, near old chaman and was felt over a large area of Baluchistan, giving rise to a fissure which was traced for 120 miles.

(*b*) In the autumn of 1897 a slight shock was felt in the Zhob district. Though several houses are said to have collapsed, there was no loss of life.

(*c*) In 1899 an earthquake shock was felt at Kolwa and Kech in Mekran.

(*d*) In the Quetta-Pishin district a severe earthquake occurred in 1900, giving rise to a spring in the Sraghurgi village on the slopes of Takatu, which after a time, disappeared. The last severe shock of this district was that of 1902, which did much damage to the buildings in Pishin, Kila, Abdulla and Geulistan.

(*e*) In the Loralai district, several houses were destrayed in the village of Bori, and fissures are said to have been caused in the mountains, due to an earthquke shock occurring in December, 1901.

(*f*) In the Kachhi district which has been subjected to severe earthquakes very frequently, a shock of a very severe intensity was felt at Dadhar on the 23rd Dec. 1903, in consequence of which 60 houses were razed to the ground and some human lives lost. The loss of property was estimated at about Rs. 15,000.

Earthquake of October 21, 1909.

This is one of the most severe earthquakes. It reached its greatest intensity along a line running from Shahpur north-westwards through Muradwa, Janu and Bellpat to beyond Karula. The shock reached an intensity of degree 9 on the Rossi-Forel scale within the epicentral tract. In this area the villages were completely destroyed, most of the houses falling down.

Notes and News

The appointment of the Hon'ble the Marquis of Zetland as the new Secretary of State for India will be welcome to all sections of Indians in this country. As Governor of Bengal from 1917-22, he achieved great success and won popularity with Indians and Europeans alike. Educated at Harrow and Trinity College, Cambridge, he takes a keen interest in the study of the countries and the peoples of the East. An ardent traveller, His Lordship is the author of many books of travel amongst which mention may specially be made of 'On the Outskirts of the Empire of Asia', 'A Wandering Student in the Far East,' and 'India : a Bird's Eye View.' Among his other important works, 'The Heart of Aryavarta' and the 'Biography of the Late Lord Curzon' are the most well-known.

It will be interesting to add in this connection that it was Lord Zetland who along with Prof. F. W. Thomas of Oxford sent a circular letter to the distinguished men of letters and science in India two years ago, suggesting the formation of an academy on an all India basis for the promotion of Sciences and Letters in this country. This idea gave rise to the Academy movement on the part of the Indian scientists, of which so much has been heard during the last two years and which at last culminated in the foundation of the National Institute of Sciences of India in January, 1935. Every one of us who knows Lord Zetland's intimate knowledge of Indian affairs, his wide outlook and lastly, his sympathetic attitude towards India, will look upon this official connection of his with India as highly satisfactory, and we have no doubt that during the tenure of his office, the cause of science will receive greater patronage from the Government of India.

*   *   *   *

We offer our best congratulations to Kunwar Sir Jagdish Prasad, Member for the Department of Education, Health and Lands, Government of India on his being knighted by His Majesty's Government. After a brilliant academic career at Allahabad and then at Cambridge, Sir Jagdish Prasad joined the Indian Civil Service in the early part of the twentieth century, and was posted in the United Provinces. He soon achieved distinction as a civilian and as a mark of appreciation for the meritorious services rendered, the Government conferred upon him the title of Kunwar, and appointed him first as the Chief Secretary, and then as an Executive Councillor in the Government of the United Provinces of Agra and Oudh. Here too, he enjoyed unique reputation, and proved a very valuable asset to the Government. A few months ago, when Sir Fazl-i-Hussain retired from the membership of the Government of India, Kunwar Sir Jagdish Prasad was appointed his successor. His Majesty's Government have recognised his abilities for a second time and conferred upon him a knighthood. We hope that under Kunwar Sahib's tenure of office, education in India will prosper more and more.

*   *   *   *

In opening the All India Modern History Congress at Poona on the 8th of June, 1935., His Excellency the Governor of Bombay, put in a strong plea for the scientific study of history. Some regard history as philosophy and others as fiction. Voltaire regarded the histories available in his own time as stories of high way robbery. In our country, unfortunately, to both teachers and students, history is hardly anything more than a monotonous record of wars and assassinations. But history is neither of these. It is, and should be, regarded as a branch of social science, and as such its importance is immense. A historian is, therefore, a scientist above anything else, and his duty is to study history objectively and impartially with a view not to support his pet theories but to discover the great laws that govern the human society in evolution. His Excellency has expressed this view beautifully in the following words :

"It is easy to pick out events which confirm a certain theory of life, but the historian must start from no such theories. He must not take for granted that there was a golden age in the past nor that we are working up towards a golden future. He must not accept blindly the divine right or inevitability of any institution or custom nor the sanctity of theories of the rights of man, nor must he judge actions and events in terms of morals and ethics. The work of the historian is merely to calculate the results of event upon event and action upon action".

Dr. Sir Shafaat Ahmad Khan, who presided over the Congress, strongly urged for the appointment of a Manuscript Commission in the course of his presidential address. This Commission is to make a scientific study of the innumerable manuscripts of great historical value available in India. As such a task would present many difficulties to private bodies, he suggested that the Government of India should put its head into the matter by organising a small body of highly trained men for this work. Everybody will agree with this suggestion.

Sir Shafaat Ahmad Khan concluded his speech with the expression of his own views about the ideals of teaching history to Indian youths. "A great deal depends", he said, "on the means in which the youth of India is taught history during the impressionable period of adolescence, as well as on the methods and spirits in which historians perform this task. We can enable her to reach her full stature by infusing spirit of Indian nationality into our writings, by avoiding sectional views and prejudices and popularizing the idea of common nationality. I hope and believe that it will be performed by us with zeal and enthusiasm which has always characterised our best and noblest efforts in the past." These words breathe a very noble spirit, and we hope that the worthy doctor who is also a political leader of the community he belongs to will live up to the precept he has preached.

* * * *

In the last Birth Day Honours List. Dr. L. L. Fermor, F. R. S., Director of Geological Survey of India, has been knighted and Lt-Col. R. Knowles, Professor of Proto-Zoology in the School of Tropical Medicines, Calcutta, made a C. I. E. Both are founder-members of the National Institute of Sciences in India, Dr. Fermor being also the first elected president of the Institute. We offer our heartiest congratulations to both of them.

* * * *

The Royal Society of Great Britain was pleased to sanction a research grant of £150 to Prof. M. N. Saha of the Allahabad University towards the cost of his experiments on the Thermal Ionisation of Gases.

* * * *

The Executive of the Carnegie Trust of the British Empire have awarded three Carnegie Oversea Fellowships to Prof. T. H. Laby of the University of Melbourne, Australia, Prof. M. N. Saha, D. Sc., F. R. S., of the Allahabad University, India, and Prof. T. J. Haarhaff. B. A. Litt. D. of the University of Witwatersrand, South Africa.

Lady Tata Memorial Trust

The awards of the following scholarships and grants for the year 1935-36 have been announced by the Trustees of the Lady Tata Memorial Trust :—

No.	Name.	Subject of Research	Name of the Professor to guide the Candidate.	Amount.
	Dr. Martin C. Gordon Israels. (British)	Tissue culture to problems of leucaemias and pernicious anaemia.	Dr. J. F. Wilkinson, Director of Dept. of Chemical Investigation, Royal Infirmary, Manchester.	£ 400
	Dr. Max Otto Kaalund Jorgensen (Danish)	Experimental investigations on the myelosarcometosis in mice.	Dr. Carl Krebs, Director, X-rays and the Cancer Research Institute of Aarhus, Jutland,	£ 400
3.	Dr. Walter Bungeler. (German)	Reaction of leucaemias by chronic indol intoxication in mice.		£ 400
4.	Dr. Charles Oberling. (French)	Transmissible leucaemias of hens and their relationship to the Sarcomas.	Prof. G. Roussay, Professor of Pathology in the Faculty of Medicine, Paris.	£ 400*
5.	Dr. Julius Engelbreth Holm. (Danish)	On virus of hen leucaemias together with therapeutic investigations.	Dr. Oluf Thomsen, Director, Institute of General Pathology, University of Copenhagen.	£ 400
6.	Dr. Lucy Wills. (British)	Macrocytic nutritional anaemia of monkeys, also regeneration of blood by yeast treatment.	Prof. W. W. C. Topley, Director, Dept. of Bacteriology, and Prof. H. Raistrick, Director, Dept. of Bio-Chemistry, London School of Hygiene and Trop. Medicine.	£ 400
7.	Prof. Eugene. L. Opie. (American)	Leucaemias like diseases of fowls and their relation to neoplasms and to determine the nature of viruses, producing leucaemias, neoplasms etc.	..	£ 300
	Dr. Phil Karl Hinsberg. (German)	The metabolism of fat, copper and glutathione in leucaemias	Prof. R. Rossle, Director, Charite Krankenhaus, Berlin University.	£ 300

+ £ 200 for non-recurring expenditure.

Lady Tata Memorial Trust.

Indian Scholarships.

No.	Name.	Subject of Research	Name of the Professor to guide the Candidate.	Amount. p.m.
1.	Mr. Nirode Chandra Datta, M. Sc.	Tin in Nutrition and the effect on body of Mineral Contamination of foodstuffs during cooking and storage.	Prof. V. Subrahmanyan, D. Sc. Dept. of Chemistry. Indian Institute of Science. Bangalore.	Rs. 150/-
2.	Mr. Kedar Nath Gaind, M. Sc.	To synthesise new compounds possessing local Anaesthetic Properties.	Dr. J. N. Ray, D. Sc., F. I. C. Prof. of Organic Chemistry, University Chemical Laboratories, Lahore.	" "
3.	Mr. Madhav Chandra Nath, M. Sc.	Chemical and Biological Analysis of Proteins of Indian foodstuffs.	Dr. K. P. Basu, D. Sc. Bio-Chemist, Dacca University.	" "
4.	Mr. Yelandur V. Srinivasa Rao, M. Sc.	To study the proteins of Indian foodstuffs, Chemical and Biological Analysis.	Prof. C. A. Rojahn, Director, Institute for pharmacie and Nahrungsmi Hel chemie, der universitat, Halle, Germany.	" "
5.	Mr. Ram Kanta Chakravarty, M. Sc.	To investigate nutritional problems of Indian foodstuffs with special reference to vitamin C.	Prof. H. Ghosh, Director, Indian Institute of Medical Research, Calcutta.	" "
6.	Mr. Nalin Bandhu Das, B Sc.	Oxytocio hormone and oxidation—reduction systems in the body.	Prof. Hansvon Euler, Bio-chemical institute, University of Stockholm.	" "
7.	Mr. Tejendra Nath Ghosh, M. Sc.	Preparations of new Antimalarials.	Dr. P. C. Guha, D. Sc. Director, Dept. of Organic Chemistry. Indian Institute of Science Bangalore.	" "
8.	Mr. Harbhajan Singh Mahal,	Anthelmintics synthesis of substances and examination of Indian plants having anthelmintic properties.	Dr. T. S. Wheeler, F. I. C. Principal, Royal Inst. of Science, Bombay.	" "
9.	Dr. Birendra K. Nandi, Ph. D.	Synthesis of antimalarials on the lines of plasmochin and atebrim types.	Prof. R. Robinson, F. R. S. Dyson Perrins Laboratory, Oxford University Oxford.	" "
10.	Mr. H. B. Sreerangachar, M. Sc.	The growth-promoting and the antianaemic properties of liver.	Prof. V. Subrahmanyan, D. Sc. Prof. of Bio-chemistry, Indian Institute of Science, Bangalore.	" "

Research Notes

A demountable type of high power transmitting valve.

In a paper read before the Wireless Section of the Institute of Electrical Engineers, Great Britain, on Feb. 6, 1935, Messrs. C. R. Burch and C. Sykes have described a power transmitting tube capable of dissipating as much as 50 kilowatts at the anode. This is of a demountable type and is continuously evacuated, but it has all the advantages of a good high power sealed up transmitting tube. It may normally be broken across one of its semi-permanent joints and any damaged part can be replaced. On the other hand the sealed up transmitting valve has to be rejected outright when any of its part is damaged. This valve can generate waves as short as 10 metres with reasonable efficiency. The evacuation is carried on with the aid of an oil diffusion pump. With this arrangement it is possible to attain any desired degree of high vacuum, for the oily substance used in the pump has a very low vapour pressure even at room temperatures. For external connections the filament, grid and the plate are connected to copper flanges, which are insulated from each other by porcelain or silica insulators and carry water cooling channels, so that the various joints can be kept cool. A series of water cooling channels is machined in the anode as well, and very satisfactory cooling is maintained throughout.

B. D. Pant.

Red Auroral Rays—The luminous glow observed in the atmosphere round the north or south polar regions during their respective winter months has excited the interest of scientists for over a century. Some years ago, H. Babcock of the Mount Wilson Observatory measured the wavelength of the most conspicuous line by means of the Fabry-Perot interferometer, and found it to be λ 5577·35 A. units. A few years after, Prof. J. C. Maclennan of the Toronto University, Canada, obtained the line in a discharge tube containing oxygen, and some inert gas, and later was able to show that it is due to oxygen alone. It has now been ascertained that the line is due to the forbidden transition $2p^2\ {}^1D_2 - 2p^2\ {}^1S_0$.

The lowest state of the oxygen atom is given by $2p^2\ {}^3P_{0,1,2}$. It is therefore natural to expect that the aurora would give, besides the green lines, two lines due to the transition ${}^3P_{1,2} - {}^1D_2$. These lines were found by Frerichs in the discharge tube and their wavelengths were given as λ 6300 and λ 6364 A. units.

Evidence of the existence of the red lines in the aurora has so far been unconvincing. Certain auroras are in fact found to display a red colour, and when spectroscopic measurements were taken, lines were found in the positions expected, but they were mixed up with the lines of the first positive band of nitrogen, the wavelengths of some of which agree with those of the red auroral lines.

In a recent note to *Nature*, April 6, 1935. Prof. Vegard and Mr. Harrang, describe the results of experiments undertaken at the Tromso Geophysical Observatory, for finding out accurately the wavelengths of the red lines with the aid of a Fabry-Perot interferometer. The wavelengths determined are yet uncertain to the extent of $\pm$ 1 A. units, but the results so far obtained indicate that the red lines are present in the spectrum of the aurora. If as expected, the investigation is confirmed, it will clear up an obscure point in auroral spectrum which has for sometime been very baffling.

M. S.

Hydrogen isotope of mass 3

One of the most important cases of artificial transmutation which have been investigated is that in which compounds containing heavy hydrogen are bombarded with high velocity

$_1H^2$ ions. Oliphant, Harteck and Lord Rutherford first showed that such bombardment resulted in a copious emission of two proton groups of range 15.0 cm. and 16.0 mm. the relative numbers of particles in the two groups being equal within the errors of measurements. The mechanism for the process involved in the reaction was assumed to be

$$_1H^2 + _1H^2 \longrightarrow {}_1H^1 + {}_1H^3.$$

$_1H^3$...is a hydrogen-isotope of mass 3.

In addition to this proton emission the same authors showed that an intense neutron emission resulted from this bombardment. Just a year ago P. T. Dee showed in a communication to ***Nature*** that these neutrons were probably homogeneous and that their energy was 1.8×10^6 electron volts. An investigation using a linear counting chamber gave a maximum value for the neutron energy of about 2×10^6 electron volts. To account for these neutrons Oliphant Harteck and Lord Rutherford proposed the following reaction

$$_1H^2 + {}_1H^2 \rightarrow {}_0n + {}_2He^3.$$

and utilising the value of the mass of $_2He^3$ (3.0166) as obtained from the data for the disintegration of $_34^6$ by protons and a neutron mass of 1.0067 they showed that the energy of the neutrons calculated from the second formula was 2.5×10^6 e. v. which was in approximate agreement with the experimental value.

Difficulty arose when attempts were made to detect these $_2He^3$ nuclei by counting methods. The range to be expected was only 5 mm. and the detection of particles of such short range was very difficult and could not be expected under experimental conditions used by Oliphant, Harteck, Lord Rutherford. P. T. Dee and C. W. Gilbert by an application of the laws of conservation of energy showed [*Proc. Roy. Soc.* A. *149.* 201. 1935] that the range of $_2He^3$ nuclei which may be ejected in the direction of the bombarding $_1H^2$ ions, is appreciably greater than for those emitted at right angle to the incident beam. After passing a beam of artificially accelerated $_1H^2$ ions into a gas mixture containing heavy hydrogen they, detected the $_2He^3$ nuclei. The range of this group of particles has been measured and is 4.3 ± 0.2 mm. for zero bombarding energy. The neutrons produced in the same bombardment have an energy of $1.8 \pm 0.2 \times 10^6$ electron volts, and it is shown that these results are in agreement with the application of the conservation of momentum to the process assumed. A value of 1.0080 ± 0.0004 is thereby deduced for the mass of neutron.

S. C. D.

Antiquities from the Indo-Iranian Borderland.

The latest number of the *Journal of the Royal Anthropological Institute* (*64* July to December, 1934) contains an article with the heading 'The Indo-Iranian Borderlands' by Sir Aurel Stein. Sir Aurel's archaeological tours have always been rich in their results, but those described in this article are particularly interesting as they aimed at tracing the links between the ancient culture of Sind and Elam-Mesopotamia. Numerous pre-historic sites have been discovered in all parts of Baluchistan and even on the Iranian frontier, and it is regrettable that political circumstances prevented him from exploring the Afghan border as well. In most of these sites Stein found painted pottery and pottery debris and in some, e.g. the Mehi mound, Kolwa and Turbal he was fortunate in recovering some cult objects, such as representations of the phallus, humped bulls and the mother-goddess, which definitely establish their affinity with the Mohenjodaro relics. These remains are all non-Aryan, and though the existence of a colony of Aryan-speakers is now becoming more and more evident in the Near East, no trace of any Aryan occupation of these lands has been found. On the other hand, these remains 'attest the essential unity of the civilization which existed during chalcolithic times in the border region between India and Iran.'

It is noticeable that the coast of the Persian Gulf has so far not been found to contain any site of respectable antiquity. This tends to show that the communication between the Indus valley and Sumer was more by land than by sea.

The existence of the Dravidian-speaking Brahuis on Jhalawan and Sarawan hills just

above the plains about Mohenjodaro has long been an enigma to linguists. But with the increase of our knowledge of the Proto-Indian Culture, it seems more reasonable to regard the Brahuis as the residue of the Dravidian population of these regions rather than a drift of the Dravidians to the north-west as has been suggested by Grierson.

A. G.

Ozone in Earth's Atmosphere

It has been so far believed that ozone gas which is responsible for the sharp cutting of the sun's spectrum near about λ 2950 is to be located at a height of 50 kilometers, within a rather thin spherical shell. Recent investigations by Goetz, Meetham and Dobson (*Proc. Roy. Soc. London. (A) 145*, 416, 1934) however speaks another tale. Up to this time the height of ozone layer has been determined from the absorption of direct sunlight at different zenith distances. These investigators have measured the intensity of sunlight scattered by the earth's atmosphere at different zenith distances of the sun. The intensity was determined spectrophotometrically from λ 3110 upto λ 3290. A. U. They showed that this method yielded a better way of determining the distribution of ozone in the earth's atmosphere. Their general conclusion is that ozone is to be found even at the surface of the earth, but its amount per kilometer increases rapidly and reaches a maximum between 25 to 30 kilometer where it attains a concentration of one tenth millimeter at N. T. P. per kilometer depth of the atmosphere. This investigation has been further confirmed by the pilot baloon experiments of E. and V. Regener (*Phys. Zeits. 35* 788, 1934) carried out at the Stuttgart Physical Institute. They sent up a pilot baloon carrying a small quartz spectrograph the collimator tube of which was directed on a mat surface consisting of white magnesium which was suspended from the gondola. The sunlight directly reflected from the surface enters the spectrograph and was photographed on a circular film after definite interval of time for a short period. In this way spectrograms of sunlight were obtained at different heights. In the three ascents made so far, in which heights of 20,21 and 31 kilometers were reached, it has been found that the spectrum shows an increase in extension in the ultra-violet with the height attained. The result so far attained are only qualitative and the limit of solar spectrum photographed at the earth's surface has not yet been exceeded. This is because while at the earth the exposure can be made as long as possible, this is not possible when photographs are taken in the ascending baloon. But the investigators feel that if they could have their spectrographs directed towards the sun and allow longer exposures, the spectrum would be found to extend much beyond the existing ozone limit. They are of opinion that at a height of 31. kilometer, most of the ozone layer is left below.

M. S.

Nature on the New Relativity Theory.

Nature comments as follows on Sulaiman's New Relativity theory : A second instalment of Sir Shah Sulaiman's new theory of relativity has appeared (*Proc. Acad. Sci. U. P. India 4*, 217); the first part appeared in the same journal (*4*, 1) in August 1934. The author retains Euclidean space, and as much as possible of Newtonian dynamics, the chief deviation being the hypothesis that gravitational, electrical and magnetic forces do not act instantaneously, but are propagated with a velocity nearly equal to that of light. Light is supposed to consist of 'radion' emitted from the surface of bodies, gravitation of 'gravitons' from their entire mass. From these hypotheses four universal principles are deduced. Two of these, akin to Doppler's principle and aberration, deal with the modification of the magnitude and direction of the gravitational force upon a moving body, and these are applied to the advance of the perihelion of Mercury, the deflection of light by gravitation, the spectral shift, and the experiments of Michelson and Morley, and of Bucherer. Another gives a formula for the relative velocity of two moving bodies, which is applied to the experiments of Fresnel and of Fizeau. The remaining one is applied (in outline only) to the fine structure of the hydrogen spectrum.

The idea of an expanding universe is firmly rejected, though it is allowed that some nebulae, formerly part of our galactic system, have left it on parabolic paths. In short, an attempt is made to give an alternative explanation for the whole range of phenomena usually adduced in support of Einstein's theory. It is difficult to form a definite opinion whether the author's work is entirely sound, but he has evidently studied all the standard works. The mathematics has been checked by two competent mathematical physicists, and works have been carried out with the encouragement of Prof. M. N. Saha. If it can stand the test of criticism, it will obviously be of great importance.

Radio Sodium

It was discovered by M. and Mme. Curie and Joliot about a year ago that new radioactive atoms are produced by the bombardment of atoms of low atomic numbers with α-particles (phenomenon of induced radioactivity). The artificially produced radio element which was first obtained by them is a radioactive isotope of phosphorus. This was produced by the bombardment of aluminium with α-particles. Since the first discovery, more than 50 radioactive isotopes have been produced by various observers by the bombardment of ordinary atoms of elements, the projectiles used in some cases being α-particles, and in other cases deutons or neutrons (Fermi). Some of these new radioactive istopes, while disintegrating, emit positrons while other emit electrons, and the period of decay varies from a few minutes to a few hours. In the January issue of the *Physical Review* Lawrence has reported that radio-sodium, a new radioactive isotope which is produced by the transmutation of sodium under deuton bombardment, possesses very important radioactive properties. The period of decay of radio-sodium was found to be fifteen and a half hours. Of all artificially prepared radioactive elements, it has got the longest life. It has been found to decay with the emission of electrons with energies up to $1{\cdot}2 \times 10^6$ e. volts, but, what is more important, it hasbeen found to emit a γ-radiation of extraordinary high energy viz. $5{\cdot}5 \times 10^6$ e. volts. This γ-radiation is much harder than the $2{\cdot}6 \times 10^6$ e. volt γ-radiation emitted by natural radioactive elements. The properties of radio-sodium are thus comparable to those of natural radioactive elements and in near future, radio sodium may be used as a better and cheaper substitute for radium, especially in hospitals for the purpose of treatment by γ-radiation. At present about 1/200 of a millicurie of radiosodium is produced by a stream of deuton nuclei which are accelerated by a high voltage generator giving approximately a velocity of $1{\cdot}7$ million electron volts and constituting a current of a micro ampere. If either the current or the voltage is increased, the yield of radio-sodium may be increased many times and it is not improbable that even with apparatus within the reach of industrial concerns the yield may be increased a hundred or thousand fold. We may think of a day when institutions may be founded in big cities which will possess a H. T. plant which will produce radio-sodium and this radio-sodium will then be given to medical practitioners in place of radium. At the present time, radium can not be used internally. But there is a possibility that radio-sodium may be applied internally as well. The discovery therefore promises a revolution in radium treatment in no distant future.

P. Meriggi on the Indus-script.

The momentous archaeological discoveries in the Indus-valley have revolutionised the whole conception of Indian history, for it has to be admitted now that Indian history proper began at least two thousand years before the advent of the Aryans in India. As in Greece the pre-Aryan Pelasgian civilisation was destroyed by Aryan invaders, viz. the Achaeans and the Dorians, so in India too, the great Indus civilisation appears to have fallen a prey to hordes of Aryan barbarians. But who were these Indus people? The question remains unanswered as yet. It can be answered only when the short legends on their seals are deciphered, and it is to be hoped that further discoveries will throw more light on the matter. The progress already made in this direction permits us at least to hope that the tragedy of

Etruscology will not be repeated in the case of India (of the thousands of Etruscan inscriptions, not one has been deciphered so far). One Rosettastone sufficed to divulge the secrets of the Egyptian pyramids to Champollion and Grotefend, and Rawlinson deciphered the old Persian inscriptions with the help of equally meagre material. That the prospect of deciphering the Indus-seals is not all too dark appears to follow from a paper by Meriggi in the ***Zeitschrift fur Deutschen Morgenlandischen Gesellschaft***, ***12***, 199, 1934. In this article Meriggi has given us but a fore-taste of what is contained in his forthcoming comprehensive work on the Indus-script.

A very careful study of all the seals along with the literature thereof has led him to conclude :—

(1) The normal direction of writing is from ***right to left***, but in the case of longer legends it may be often ***bustrophedic***.

(2) The basic symbols are very numerous, about 275. The system must have been an "ideo-phonographic" one,—some symbols representing mere sounds and others representing mere meanings. Both kinds of symbols may however be used in one and the same word. (A similar ideo-phonographic system was followed in the Manichaean-Pehlevi manuscripts (third to sixth century A. D.)

(3) For the purpose of word-division, two frequently recurring symbols, perhaps of case-ending, are of supreme importance. But word-division was indicated perhaps also by a raised comma-like vertical stroke.

Starting with these assumptions, Meriggi has built up a code of decipherment which at first sight appears to be frankly fantastic. He has naturally always tried to connect the legend on a seal with the object represented on it. In this way the ***meaning*** of these short legends may be understood comparatively easily, and, if Meriggi is right, it will not be long before all the seals have been deciphered in that sense. But the question of determining the phonetic values of these symbols is quite a different one, and Meriggi too has not dared to hazard any statement on that point.

Batakrishna Ghosh.

Letters to the Editor

Active Principle of Piper Chaba, Hunter.

Piper Chaba, Hunter (Sans.—Chavika, Beng.—Choi) is an indigenous drug of India. According to Kirtikar and Basu[1] it 'partakes of the stimulant and carminative properties of black and long pepper. Its use in haemorrhoidal affections is noticed in Taleef Shereef (p. 66)'. A chemical investigation of the dried stem of the above plant shows that the active principle is piperine which is present to the extent of 0.38%.

Chemistry Department, P. K. Bose.
University College of Science
Calcutta. May 15, 1935.

1. *Indian Medicinal Plants.* II, p. 1092.

The Interference of Ascorbic acid in the Chemical Estimation of Adrenalin in the Adrenal Gland.

Numerous papers have been published on the adrenalin content of the adrenal gland of various species, in which chemical methods of assay have been used. Practically all these methods are based on the reduction of some reagent by adrenalin and for some years the tungstic acid reagent of Folin [1,2] has been in general use. In this reaction a blue colour is developed when the adrenal extract is treated with the reagent and the intensity of the blue colour is estimated.

The isolation of hexuronic acid (now known as ascorbic acid and identified with Vitamin C) from the adrenal gland, which is now known to be a rich source of this strongly reducing substance, has seriously complicated this question. It would seem *a priori* that this substance would also reduce the tungstic acid reagent and we have, in fact found that an intense blue-violet colour is produced readily in the cold when Folin's reagent[2] is treated with a dilute aqueous solution of ascorbic acid.

The earlier results on the adrenalin content of the adrenal gland, obtained by this chemical method, would thus appear to be badly vitiated by the simultaneous presence of ascorbic acid in the adrenal extract. It would seem that the previous removal of ascorbic acid by means of lead acetate or by some other means from the adrenal extract would be necessary for the estimation of adrenalin by means of Folin's reagent.

Biochemical Laboratory, B. C. Guha.
Bengal Chemical &
Pharmaceutical Works, Ld :
Calcutta.
May 7, 35.

1. Folin, Cannon and Denis *J. Biol. Chem.*, *13*,477, 1913,
2. Folin and Trimble *ibid*, *60*, 472, 1921.

The Effect of Aggregation on the Cataphoretic velocity of Colloidal particles.

Measurements on the cataphoretic velocity of colloidal particles carried out in this laboratory[1] since 1923 enable us to arrive at the following conclusions among others :

(a) It is not possible to postulate the existence of a critical coagulation potential, either for a given colloidal solution and different electrolytes, or, for a given electrolyte and colloidal solution of the same substance obtained in different ways. The differences are so large that possible changes in the dielectric constant[2] cannot account for them. Besides, coagulation sometimes takes place when the c. v. is about 50% greater than that of the original sol.

(b) The form of the curve representing variations of the c. v. with the concentration of added electrolytes depends to some extent on the magnitude of the c. v. of the particles of the sol. The c. v. decreases on the addition of an electrolyte having univalent ions of opposite sign if the c. v. has a high value for the particles of the sol. It often increases if it has a low value.

(c) For electrolytes with a univalent coagulating ion, the c. v. often increases at the higher concentration and specially near the stage of rapid coagulation. There is also a distinct difference between the shapes of the curves obtained with electrolytes having univalent and polyvalent coagulating ions. The conclusion was drawn that the aggregation[3] of the particles increases the c. v. and that the manner of entrainment of the coagulating ions requires to be considered in explaining electrolytic coagulation.

(d) The c. v. drops sharply after coagulation.[3]

In view of the recent observations of Robinson[4] of the effect of aggregation on the mobility of the particles of Benzopurpurine B, we give below some typical observations from the measurements of Mr. K. D. Bhaback. The best course to follow the effect of aggregation on the cataphoretic velocity would be to use suitable concentrations of an electrolyte which produce a rate of coagulation which is

neither too rapid nor too slow. The first measurements were made with the boundary method but the microcataphoretic method has been used for the measurements given below. The c. v. increases with time as the aggregation proceeds and falls sharply on coagulation.

TABLE I (arsenious sulphide sol)
C. V. × 10^5 cm. per sec. per volt/cm.

Electrolyte	Time after mixing in minutes.	Before Coagulation.	After coagulation.
Nil		31.65	—
$\frac{N}{6}$ KCl	12 to 21	40.42	35.2
	40 " 55	43.75	
	5 " 12	40.7	
	40 " 45	45.78	33.54
	77 " 84	44.66	
$\frac{N}{8}$ KCl	12 " 16	39.91	
	21 " 28	40.33	
	24 hrs.	49.77	
	14 " 18	40.04	17.67
	24 hrs.	50.01	
$\frac{N}{300}$ $BaCl_2$	6 " 10	17.11	
	52 " 58	21.06	17.54
$\frac{N}{3000}$ $AlCl_3$	3 " 8	12.29	
	19 " 22	16.94	12.13
	30 " 34	18.47	

TABLE II (palmitic acid sol)
C. V. × 10^5 cm. per sec. per volt/cm.

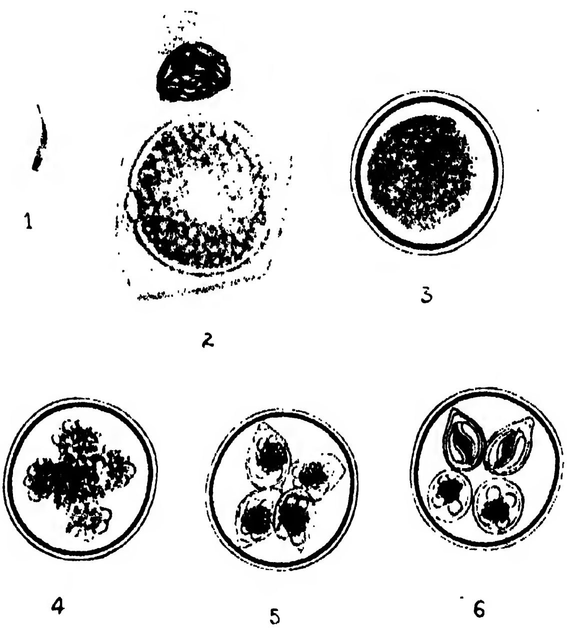
Electrolyte	Time after mixing in minutes.	Before coagulation.	After coagulation.
Nil	--	7.42	—
$\frac{N}{2}$ KCl	2 to 9	17.32	18.1
	57 " 62	20.65	
	2 " 12	17.08	
	61 " 71	20.6	
$\frac{N}{100}$ $BaCl_2$	2 " 7	12.6	
	60 " 63	18.92	
	120 " 123	18.61	11.86
$\frac{N}{800}$ $AlCl_3$	2 " 7	18.94	
	17 " 21	21.73	
	23 " 31	24.63	
	41 " 44	27.85	
	61 " 64	27.02	

J. N. Mukherjee.
Physical Chemistry Laboratory, S. G. Chaudhury.
University College of Science and Technology,
92, Upper Circular Road,
Calcutta. The 5th June, 1935.

(1) (a) J. Ind. chem. Soc., 1925, *2*, 296 ; (b) ibid, 1927, *4*, 493 ; (c) *ibid*, 1928, *5*, 697 ; (d) ibid, 1928, *5*, 735 ; (e) ibid, 1931, *8*, 373 ; (f) ibid, 1933, *10*, 27, 405, 713.
(2) see 1 (c), 1 (d).
(3) see 1 (d) and 1 (e) ; Chaudhury, ibid, 1933, *10*, 446.
(4) Proc. Roy. Soc., 1934, 143A. 130.

Wenyonella (Coccidia) from an India Squirrel.

The genus *Wenyonella* was founded by Hoare[1] for a coccidian *W. africana* infecting the small intestine (Subepithelial region) of *Boaedon lineatus* (Ophidia, Colubridae) from Entebe, Uganda. This new type of Coccidia is characterised by *tetrazoic tetrasporocystid* oocysts. While examining the gut contents of a squirrel, *Sciurus sp.*, we came across another species of *Wenyonella* which differed from the type species *W. africana* Hoare, in its dimensions and other features.



Oocysts are perfectly spherical and measure 14-18. 4μ in diameter (Fig. 3). The sporocysts show the characteristic lensiform "Knob" at one pole and measure 10μ in length and 8μ in breadth. Sporozoites are more or less regularly arranged with broad end of two sporozoites at one pole and two at the other (Fig. 6). We were fortunate in getting all the endogenous stages in both fresh and stained preparations. In a fresh preparation merozoites measuring 8. 2 x 2. 05μ were seen actively swimming about with the pointed end directed forward (Fig. 1). Female gametocyte showed a micropyle (Fig. 2) which of course was not found to persist in the oocyst. Development of mole gametes was also followed in the living condition. Advanced male gametes were seen to adhere round a central mass of cytoplasm with their tail ends actively moving away from it. Within a course of an hour and a half these gametes were seen to break off from that central mass and then congregate round the micropylar end of a female gamete. After a while a slight agitation was observed in the cytoplasm of the female

gamete. Our observation ceased here because most of the specimens began to show signs of degeneration.

Oocyst after being kept in 1% chromic acid showed the first sign of development after fortyeight hours. At the end of this period the zygote showed four prominences with four homogeneous bodies budding out of each of these prominences (Fig. 4). On the fourth day four sporoblasts were seen to separate from each other (Fig. 5). It was on the fifth day that the sporoblasts became invested with a sporocyst, while sporozoites became well differentiated on the seventh day. This whole process is quite unlike what has been described for *W. africana*.

This is the first time that a coccidia of the genus *Wenyonella* is described from a mammalian host. In our detailed paper, which will be published elsewhere, we propose to call it *W. hoarei* n. so., the specific name being given in honour of Dr. Cecil Hoare, the founder of the genus.

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Calcutta, the 24th. April, '35.

1. *Parasitology*, 25, 1933.

Hanging Roots of Ficus Religiosa Linn and Ficus Rumphii, BL.

Ficus religiosa (Aswatha) differs from *F. rumphii* (Gaya Aswatha) mainly as regards the morphology of leaves, viz. *F. religiosa* leaf has prominently tapering *accuminate* apex while *F. rumphii* leaf has *slightly tapering acute apex*. I have observed in the course of field-excursion with students that the aerial roots of *F. rumphii* and *F. bengalensis* hang down in the air, while those of *F. religiosa* become soon attached to the surface of trunks or branches, they do not hang down as the former. The number of xylem and phloem strands in the stele of such aerial hanging roots of *F. rumphii* and *F. bengalensis* varies from 5 to 8, while in the case of *F. religiosa* it usually varies from 3 to 5. The underground primary roots of these plants usually have fewer number of xylem and phloem strands in the stele, for instance, in the case of *F. religiosa* the number is usually 2 and in the case of *F. bengalensis* it is 3 and 4. A number of plants have been examined for the purpose. It seems that this phenomenon has not been recorded so far.

What is the cause of this difference in behaviour between the kinds of roots? I appeal to plant-physiologists to find out if it is a case of positive geotropism in one (*F. rumphii*) and lateral geotropism in the other (*F. religiosa.*) May I request botanical workers in different parts of India to keep an eye on such roots and to kindly communicate to me if my observation regarding these roots is confirmed or negativated in the course of their observation?

I am indebted to Mr. Anutosh Dasgupta M. A. of the the Botany Dept. of the Bangabasi College, Calcutta, for first drawing my attention to this interesting fact.

Botanical Laboratory, S. R. Bose.
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Calcutta, May, 1935.

Colour of Paramagnetic Crystals and Solutions of the Iron Group.

Strong colours are shown by paramagnetic crystals and solutions of compounds of the iron group, due to absorption of light in the visible region. Saha[1], Kato[2], Bose and Datta[3] have developed the view that light absorption in these substances is primarily due to an electron transition in the central paramagnetic ion (one of the 3d-electrons changing its s-vector from $+\frac{1}{2}$ to $-\frac{1}{2}$), the influence of the neighbouring ions, atoms, or molecules being to lead to a shift and also a broadening of the absorption line.

Two lines of research have been undertaken by the present author to study the influence of different types of interaction between the electrons in the 3d-shell of the paramagnetic ions and the surrounding ions, atoms, and molecules, viz., investigations on the magnetic properties and absorption spectra of the paramagnetic salts of this group in the form of different types of crystals and in solution in different solvents and at different temperatures. The results of magnetic investigations have been published before[4]. The results of absorption measurements indicate that

(i) in solutions of $CrCl_3$, $CoCl_2$ and $NiCl_2$ in different solvents, when the solvent has a di-electric constant less than that of water, or when the solvent contains an excess of HCl, the absorption-maxima are shifted to a longer wavelength side with respect to that due to hydrated complexes (as in aqueous solutions), and in the case of the Cr^{+++}, for which the spectroscopic term values are known, it approaches towards the calculated values for the transitions $^4F-^2G_{4,5}$ and $^4F-^2H_{5,6}$

(ii) the absorption-maxima in powdered crystals of anhydrous chlorides lie in the longer wavelength side with respect to that due to the corresponding hydrated crystals and agree fairly well wiih the absorption maxima in et. alcohol and HCl solutions at higher temperatures.

(iii) at very low temperatures (115°C in some cases), in et. alcohol and HCl solutions the positions of the absorption bands recede towards the shorter wavelength side and agree with those due to the corresponding hydrated complexes.

The observed phenomena may be explained by assuming that in hydrated crystals as well as in solutions at low temperatures, the absorption-centres are the hydrated or similar complexes, and in crystals of anhydrous chlorides and in solutions at higher temperatures, the absorption-centres are the undissociated molecules. In the case of the complexes, the electrons in the 3d-shell are coupled with the neighbouring dipole molecules like H_2O, C_2H_5OH etc.

During the process of light-absorption by the d-shell of the paramagnetic ion, the coupling is greatly disturbed and there is a temporary dissociation of the complex when the paramagnetic ion is raised to the excited state, and the external work necessary for this is represented by the considerable shift on the position of the absorption spectra in such cases, with respect to that due to the free ion. The undissociated molecules of $CoCl_2$ etc., are held together by covalent bonds between the (4s) electrons of the paramagnetic atom and (2p) electrons of surrounding Cl atoms, and inside this there is the incomplete 3d-shell. Light-absorption is due to electron-transitions in this inner incomplete shell together with the interatomic vibrations. There is little interaction between the electrons of the 3d-shell and the neighbouring Cl-atoms bound to it, nor are these 3d-electrons in any way influenced by other neighbouring molecules etc., so that absorption spectra do not shift much in position from that due to the free ion.

The results of light-absorption measurements of these paramagnetic salts lend support to the conclusions arrived at from their magnetic measurements regarding the nature and influence of different types of interaction with surrounding ions, atoms and molecules. A detailed paper has been communicated for publication elsewhere.

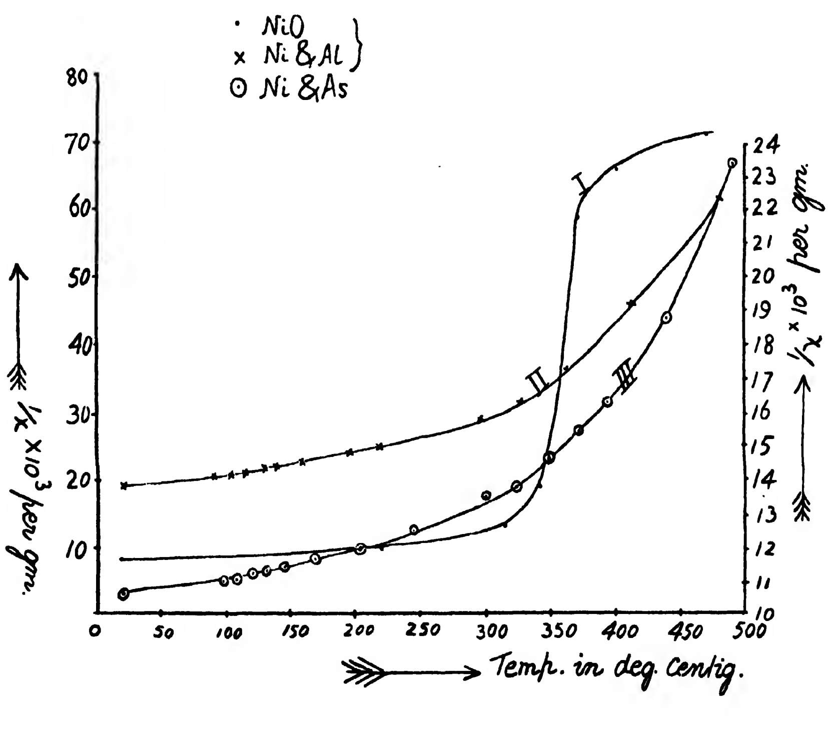
Palit Physical laboratory, S. Datta.
University College of Science.
Calcutta.
23. 4. 35.

(1) *Nature 125.* 163(1930); *Bul. Acad. Sc. U. P. 1.* 1 (1931-32).
(2) *Sc. Papers. I. P. C. R. 13.* 232 (1930).
(3) *Zeits. f. Physik 18.* 376 (1933).
(4) *Phil. Mag. 17.* 585; 1160 (1934).

Magnetic Properties of some Nickel Alloys.

Investigations[1] on NiO have shown that it possesses properties intermediate between para and ferromagnetism. Though the magnetic susceptibility $\varkappa$ depends on field strength and though there is a large drop in $\varkappa$ beyond a certain temperature—the so-called Curie point, which is here the same as for metallic Nickel—$\varkappa$ values are not as high as for typical ferro-magnetics, nor is there any hysteresis phenomenon. The present authors have been investigating the magnetic properties of some alloys of nickel and found that an alloy of 50% Ni 50%Al and another of 60% Ni and 40% As possess characteristics similar to NiO. The $1/\varkappa$– T graphs exhibit different slopes on two sides of the neighbourhood of the Curie point for pure nickel. The mass susceptibility values corrected for diamagnetism, lie between those of the pure ferromagnetic metal and its paramagnetic salts, being, however, nearer to the latter. The $\varkappa$ values and the course of the graphs discount the possibility of the existence of an appreciable amount of free metallic nickel. The alloys also exhibit the phenomenon of field dependence of susceptibility; but hysteresis is absent. It is to be noted that the change in slope of the graph is not sudden, but extends over a region of about 40°C. So it is not possible to fix a Curie point. The Ni-Al is a good conductor, while the other which is available only as a powder, is a semi-conductor.

A nickel-chromium alloy (70%Ni) has also been investigated. While for the above two alloys the $1/\varkappa$-T graphs are convex towards the temperature axis, it is concave for the latter. There is a change of curvature at about 400°C, the



lines being straight over a range of more than 200°C on two sides of it.

Graphs I and II refer to ordinates marked on the left side while graph III refers to ordinates marked on the right.

Department of physics, University College of Science, Calcutta.
May 5, 1935

D. P. Ray Chaudhuri.
P. N. Sen Gupta.

(1) Klemm and Schuth, Zeilt. *Anorg, u, Allg. Chem,* **210**, 33, 1933.

Application of Heaviside's Operational Method To The Pianoforte Problem.

Jeffreys has given in his book, 'Operational Methods in Mathematical Physics'[1], a selection of physical problems which can be easily and quickly solved with the help of Heaviside's operational method. Attention is here drawn specially to the problems of vibration of strings. A few special cases of such problems are also treated in Jeffreys' book. In the present note it is shown that the operational method can also be extended to obtain the solution of the problem of impact of the pianoforte hammer, which has been the subject of recent investigation by Raman, Das, Ghosh and others, each by entirely different methods. For instance, Raman has obtained the solution for a hard hammer in the form of a convergent trigonometric series by an extension of Lord Rayleigh's method; while Das' solution is in the form of waves as they are reflected from the extremeties. The advantages of applying Heaviside's method lies in the fact that both types of solutions can be obtained in a very elegant manner starting from a single equation; while the method is quite general and is applicable to the problems of hard or elastic hammers striking at any point of the string, we have for the present only treated the simple case of hammer, striking at a point near one extremity. The equation of motion of the hammer in this case, according to Headiside's method, is given by

$$(1) \qquad \eta = \frac{V}{\sigma + k\left(1 + \coth\frac{\sigma a}{c}\right)}.$$

where σ is Heaviside's operator, $\frac{d}{dt}$ is the displacement of the string; k a constant; a the striking distance from the nearer extremity; and c the transverse wave velocity.

Equation (1) is easily solved with the help of the Expansion Theorem, and η is obtained in the form of a convergent trigonometrical series. The solution of (1) is

$$(2)\ \eta = \Sigma\, \frac{aV\, e^{xct/a}\left(\cos\frac{\omega ct}{a} + \iota\sin\frac{\omega ct}{a}\right)}{(x+\iota\omega)\left\{1 - \frac{k\,\mathrm{cosec}^2\omega}{(x\cot\omega+\iota)^2}\right\}}$$

where the values of ω and x are known. This result holds for any time $t > 0$.

The solution in the form of waves is obtained by writing the same equation (1) in the form,

$$\eta = \frac{V\left(1 - e^{-\frac{2\sigma a}{c}}\right)}{(\sigma+2k)}\left\{1 + \frac{\sigma e^{-\frac{2\sigma a}{c}}}{\sigma+2k} + \frac{\sigma^2 e^{-\frac{4\sigma a}{c}}}{(\sigma+2k)^2} + \dots\right\}$$

and interpreting each term by Bromwich's rule.

The final result is given by

$$\eta = V\left[\frac{1}{2k}\left(1 - e^{-2kt}\right) + \frac{1}{2k}\left\{1 - e^{-2k\left(t-\frac{2a}{c}\right)} - \frac{\left(t-\frac{2a}{c}\right)}{1!}e^{-2k(t-2a/c)}\right\} - \frac{1}{2k}\left\{1 - e^{-2k(t-4a/c)}\right\} + \dots\dots\dots\right]$$

The first term in the bracket holds from time t=0 to time t=t, and the second holds from the interval $t = \frac{2a}{c}$ to t = t.

Details of the method and calculations, and the treatment of the different cases of interest with regard to the pianoforte problem will appear elsewhere.

Physics Dept.
The University, Allahabad.
April 29, 1935.

R. N. Ghosh.
L. P. Verma.

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(1) Jeffreys, H—*Cambridge Tracts in Mathematics and Mathematical Physics* No. 23

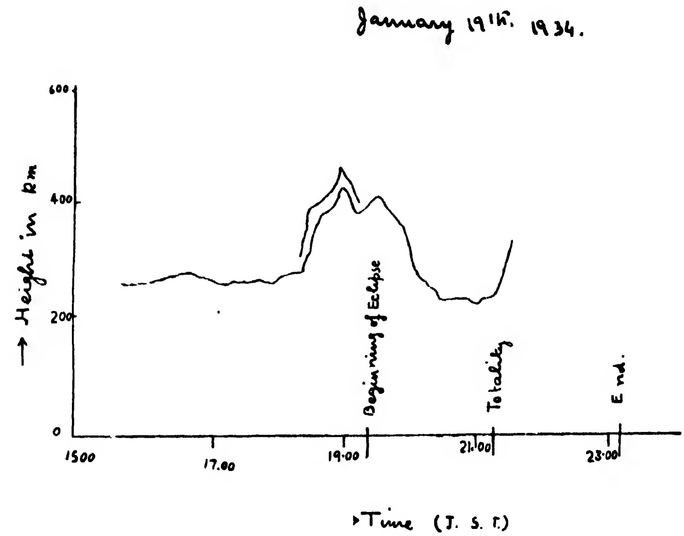
(2) Bromwich—T. J. I'A, *Proc. London Math. Soc.* *15*. Series 2, 401-448 (1917)

Lunar Eclipse and the Ionosphere

Although a lot of work has been done to study the effect of the solar eclipse on the ionosphere, yet no data are available about the behaviour of the ionosphere during the lunar eclipse. It was with this view that the ionospheric height investigations were carried out during the lunar eclipse of the 19th January, 1935, and on subsequent days. The graph attached herewith shows the temporal variations of the virtual height on the eclipse day. The wavelength employed was 75 metres, and the pulses emitted were of the duration of the order of 10^{-4} seconds. The time given is the Indian Standard Time.

Measurement of the height of the F-layer began at 15. 37. The virtual height remained 250-270 km. till 18. 20. At 18. 23 the peak suddenly split up into two components, the virtual height difference being about 30 km. The equivalent height now began to increase till at 19.00, the virtual

heights for the two magneto-ionic components were 426 and 457 km. At this time a drop of 50 km. in the virtual height of reflection of both the components was noted within a period of 15 minutes and the long delay component joined the short delay component. The virtual height again increased for a period of 15 mts, becoming 410 km. at 19. 30. km while on this occasion it was 180 km, that the peaks were visible on this day for a period much longer than on any other subsequent night, and that the lowering was almost in phase with the eclipse. These things seem to show that perhaps the eclipse was to some extent responsible for this behaviour, specially in view of the



fact that the magnetic character for the 19th January is reported to be quiet.

The lunar eclipse began at 19-23 till that time the behaviour was more or less normal as described before, but seven minutes after that the virtual height began to decrease, at first slowly and then rather rapidly reaching 225 km at 20-30, when more than half of the moon was hidden from view. The equivalent height remained almost constant till 21-17, the time of the totality of the eclipse.

After this the virtual height increased at a rapid pace reaching 310 km within a period of 20 minutes and the echoes were no longer visible after 21-35 due to electron limitation. The observations were continued till 23-30, but no echoes were visible.

At first sight it may be thought that the decrease in the equivalent height was simply due to evening concentration as noticed on some other days; but it must be noted that the height decrease due to evening electronic concentration used to occur between 19.00 20.00, while this day the lowering took place after 20.00, that during evening concentration the lowering was never more than 100

Whether this is only a chance coincidence with the evening concentration phenomenon which might have occurred at a later time on this date or the lunar eclipse has really some important influence on the ionocontent of the ionosphere can only be decided when data obtained during a large number of such eclipses are available. However, it will be interesting to take observations during the next total lunar eclipse on January 8th 1936. It is expected that it will throw some more light on the subject.

My grateful thanks are due to Professor M. N. Saha and Mr. G. R. Toshniwal for their keen interest and valuable suggestions.

Ram Ratan Bajpai.

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A Common Script for India

The daily press reports that an influential committee has been formed under the presidency of no less a personage than Mahatma Gandhi for the purpose of "discussing the reforms needed in the Devanagri script, and to evolve a programme for bringing about the desired unification of the Indian nation through the promulgation of a reformed script, based on Devanagri and Sanskrit". The personnel of the committee inspires confidence and the country will watch, with interest, their deliberations and the programme which the committee is ultimately able to submit to the country.

A lingua franca for the whole of India based on the indigenous Sanskritic languages has been the goal of not only present day patriots but also of the rulers of India throughout the ages, and it is felt that a common script should be the first requisite towards such a step. It is, therefore, not out of place to give a brief review of the case.

It is admitted by all that, of all the inventions of the human mind, that of writing has been the most potent factor in the evolution of knowledge and culture, for writing enables not only distant persons to communicate with one another, but also enables one generation to communicate its thoughts to the succeeding ones. The history of the invention has been almost identical in different parts of the world. In every country the first inventors lived to communicate their thoughts by pictures of actual objects or of scenery. The picture-writing had to undergo modifications in order to express more complex ideas. The pictographic writing ultimately developed into hieroglyphics in ancient Egypt, when pictures of certain common objects were used to represent certain fundamental consonantal sounds in the language. In Babylonia it developed into syllabic writing. The transition from *picture-writing* to *sound-writing*, whether by means of consonants or by syllables was based upon certain amount of analysis of the sounds of a language. But both types had their inherent defects. The Egyptian writings had no vowels and the symbols used for the sounds were too elaborate for ordinary use. The Babylonian method of syllabic writing contained far too large a number of symbols, and was too cumbrous for ordinary writing. Yet inspite of the great inventive powers of these two ancient nations, they could not go beyond a certain stage in the art of writing which never seems to have become universal with them, but remained confined to a particular class *viz*. the scribes.

The Chinese System

But the ancient Chinese seem to have fared still worse. They never went beyond the pictographic stage. Thus what we understand by the word

"language" does not really exist in China. They express themselves by symbols and an elaborate convention for the combination of these symbols to express more complex ideas. Thus when we write the five symbols, Woman, to express a female, the Chinese will simply draw the conventional sign for a female. If they want to denote 'wife', they will place by the side of this conventional sign for woman the sign for a broomstick, for a woman with a broomstick denotes a wife, because in China the traditional duty of a wife is to keep the house clean. In order to write "parliament", the Chinese will draw the symbols for two men and two lips which signify "many people talking together".

It is clear that such a method for preservation of ideas and their communications to persons, separated *in space* and *in time*, is very crude, and very laborious to master. It is, however, not absolutely devoid of some merits, as the same symbols are understood throughout the whole length and breadth of China by those initiated in its mysteries. In Chinese writing, pronunciation is a secondary affair, and the same symbols are said to be pronounced in different parts of the country in as many different ways as the number of days in the year. In contrast to the Indian and European languages in which the student has to master the meaning of every word with an effort, the Chinese student has to master the symbols and the proper way to combine them to express complex ideas. But alas! the effort required for a complete mastery of this process is so great that only a very small percentage is found amongst the Chinese who can be said to be literate; so there is no wonder that the Nationalist Government Party in China is thinking of introducing a new script based on the phonetic system. It is noteworthy that the more practical Japanese who got most of their elements of civilization from China never adopted the Chinese method of writing, but they took a few Chinese symbols and evolved out of them a syllabic method of writing like the old Babylonians. The nations living on the outer fringe of China, though they borrowed from the Chinese many elements of civilization, never adopted this method of writing. The Tibetans, the Koreans, and the Tartars in the middle ages, used the Indian method of writing, and their scripts were borrowed from India between the 4th and 8th century A. D. It has recently been shown that the scripts used by Attila's Huns (in Hungary) were based upon, and in some cases almost identical with, those in the Brahmi script of the 2nd or 3rd century A. D.

The Phoenician Origin of the European Scripts

All the present scripts in Europe owe their origin to the Phoenician merchants who from the 10th century B. C. onwards upto the extinction of Carthage by Rome kept up a lively commercial intercourse with the people round about the Mediterranean Sea, most of whom were then just emerging from savagery. Being an intensely practical people, they discarded the cumbrous syllabic writing of the Babylonian as well as the ornamental consonantal writing of the Egyptian, but adopted from the former 22 symbols with which they could express all sounds in their language and write all their thoughts. It is noteworthy that at first writing was entirely consonantal. It is the Greeks who in the 6th century B. C. added the vowels. The Phoenician alphabet is not only the father of the Greek alphabet, but also of the various Latin alphabets and, through them, of the present *Roman script* in which all the chief European languages are written. The North Semitic alphabets, in which at present Arabic, Persian, and Urdu are written, are also derived from the original Phoenician or Aramaic alphabet, but the South Arabic scripts (the Sabean) are said to have an independent origin.

History of Writing in India

The history of writing in India has not yet been completely traced in all its different stages of development. Before the discovery of the Indus Valley civilization, the oldest method of writing which was found in the Indian continent was *Brahmi*, used in Asoka's edicts and rock-cut inscriptions, and Kharosthi which is written like Arabic from the right to the left and which is supposed to be an adaptation from ancient Aramaic. The latter was prevalent only in the Punjab and the Afghanistan areas. The European savants were inclined to think that Brahmi had been introduced into India by the

West Indian merchants trading with the Arabs about the 8th century B. C. The theory presented many insuperable difficulties and in the light of the discovery of the Indus Valley civilization it may be said now to be an unburied corpse. The oldest system of writing so far discovered in India is of course that on the seals of the Indus Valley, which still await decipherment. The script might have been partly phonetic and partly ideographic. Prof. Langden thinks that the Brahmi script is derived from the Indus Valley script, but unless evidence leading to the transitional stage of 2000 years is discovered, this opinion remains merely a hypothesis. It is now known that the Indus Valley writing extended throughout the whole of the Punjab. We are yet in the dark as to whether the other parts of India had any independent system of writing. Curious symbols have been discovered inscribed on rocks in the jungles of the Central Provinces (Vikramkhola) and Chota Nagpur, but their meaning and relation to the Indus Valley or Brahmi script, if any, are still to be elucidated.

Subsequent History of the Brahmi Script

The history of the Brahmi script subsequent to Asoka represents in miniature the history of India. For, in Asoka's time, we find the same symbols in use from the east of present Afghanistan to Bengal and from the Himalayas to Mysore. This Brahmi script appears in Indian history all on a sudden, and the Indian savants ascribe its invention to no less a personage than grandfather Brahma, the Creator. Dismissing the question of divine invention, we can easily analyse the essential features of Brahmi as a human one. Unlike the contemporary European scripts, the Brahmi system of alphabet had two merits: (*i*) it was based upon a clear scientific analysis of the sounds of the Sanskrit language; (*ii*) in it we find the introduction of a simplified but complete system of vowels. The phonetic analysis must have been done by generations of savants with a keen analytic mind, whose last and greatest representative was probably Panini who flourished at least before the 5th century B. C. The result is that the letters of the alphabet were arranged according to a regular phonetic plan and not haphazardly as in the Roman script, and are better adopted for proper representation of sound. Whatever might have been the original scripts used by the different races and in the provinces of India prior to the introduction of Brahmi, it is quite clear that owing to its intrinsic merits combined with the patronage which it received from the Imperial Power, Brahmi soon became the only script in India; it thus succeeded in effecting a great unification of the whole of India, and this unity would have probably persisted, if the central power remained strong, or the printing press were discovered about this time. But as this was not the case, and as the Imperial Power decayed and India became subdivided into provinces, the original Brahmi script underwent local variations in form, owing either to the difference in writing materials used, or to the whims of the local calligraphists. Thus though the alphabetic system is practically the same in all the different scripts used in India at the present time except Urdu, the letters, though derived from the same common stock, have become so far differentiated that it is difficult to recognise that they are all children of a common ancestor. Our present aim is simply to restore this primitive unity, but how can we now go back again to a common set of symbols ?

We have inserted this rather long historical background in order to dispel a widespread misconception about the extravagant claims made on behalf of the Devanagri script.

Claims of the Devanagri Script unfounded

The common idea is that Devanagri is the original Sanskrit script used by the Gods and ancient heroes of India, and that the other provincial scripts like Bengali, Oriya, Gujrati, Kanarese, Telugu, Tamil etc. have grown by a process of *vulgarization* of this original script. We have shown that the claim is not justified. Devanagri is also descended, like Gujrati, Bengali, and others, from the original Brahmi script, and, as a matter of fact, it is younger in age than Bengali. For while *proto-Bengali* can be traced back to the 6th century A. D. (the oldest form has been found in a manuscript recovered in the Hariuji Temple in Japan where it was carried by Buddhist missionaries from East India in the 6th century A. D.), the same cannot be said of Devanagri, as in its present

form, it is much further removed from the scripts used in Upper India in the 6th and 7th centuries A. D. The various scripts, used in India 500 years ago, were not so different from each other as they are at the present time. The printing press has unfortunately given a fixed form to these local variations, and provincial patriotism has tended to perpetuate the differences.

The Present Problem

The present problem can be analysed as follows :—

(1) Whether the whole of India should accept the Roman script and write even their vernaculars with it, and should give up their local script.

(2) Whether Hindu India should try to substitute a common script based on the original Brahmi or present Devanagri for the whole of Hindu India, and leave the Mahomedans to the use of the script they may find most useful and convenient for their purpose.

Against the introduction of the Roman script the objections usually raised are :—

(1) That the symbols do not represent all the sounds in the Indian vernaculars correctly.

(2) That if the same symbols are used for expressing a sound in English and its nearest approach in Sanskrit or the Indian vernaculars, there would be confusion, and ultimately Sanskrit and Indian vernaculars would lose their distinctiveness.

But we think that nobody wants to introduce the Roman script as such. We may keep the phonetic basis of the Indian vernaculars, and yet give up the present symbols in favour of the Roman ones. How far this is possible for each vernacular can only be determined by a commission consisting of experts. We wish to draw the attention of the public to some factors in favour of the adoption of the Roman script :—

(1) The introduction of the Roman symbols would relieve the students of a good deal of useless duplication of labour.

(2) All the books in Pali, the sacred language of the Buddhists, are now to be found only in the Roman script. This is because, with the disappearance of Buddhism, Pali was forgotten in India, and it was discovered in Ceylon and other Buddhistic countries only about a hundred years ago by European savants. For their own convenience they began to publish these books in the Roman script, so that at the present time the large number of Indian students who offer Pali for matriculation or a higher university examination have to learn Pali, which is a purer Sanskritic language than either Bengali or Hindi, entirely in Roman script. We have come across many such students who, when interrogated, never made any complaint that the use of the Roman script was a handicap to their learning of the language. Thus we see that the contention that the Roman script is unable to express an Indian language properly and that it will further spoil the purity of the Indian languages seems to be entirely disproved. If future generations begin to learn their vernaculars from their boyhood in the Roman script, they would find the script quite as natural and convenient as the present generation finds the Devanagri or the Bengali script.

(3) The whole world has now adopted the Roman script. The Germans, who used previously the Gothic script for literary purposes, are now giving it up. Soviet Russia and the Slavonic countries still use the cyrillic script, but probably the date is not distant when the Slavonic countries will adopt the Roman script. Turkey has discarded the Arabic script for the Roman, and Iran is also going to follow suit. The adoption of the Roman script will thus bring India into closer cultural relationship with the rest of the civilized world.

(4) The adoption of the Roman script will probably bring the problem of Hindu-Moslem unity nearer to solution. For it is improbable that the Moslems will ever agree to adopt any Sanskritic alphabet for the writing of Urdu, not to speak of Persian or Arabic. But there is just a likelihood that following their co-religionists in Turkey and Iran, they may adopt the Roman script.

It may be recalled that Pandit Jawahar Lal Nehru is strongly in favour of the adoption of the Roman script for the writing of the vernaculars. A few years ago, he issued the invitation card

for his sister's marriage in the Urdu language, but it was printed in Roman types.

The Gandhi Committee appears to have discarded the possibility of the adoption of the Roman script for the Indian languages. It must be considered as an unfortunate decision, and we request the Committee to reconsider its decision. But the Committee does not appear to be oblivious of the defects of the Devanagri script ; for the press report says :—

"It is felt that in spite of the unsurpassable merit of Devanagri alphabetical system there are certain obvious shortcomings which can, however, be removed without much difficulty. These reforms are particularly desired in two or three directions. Firstly, educational ; secondly, printing and type-writing ; and thirdly, new design and typography. It is also felt that for educational purposes Devanagri needs overhauling, so that the phonetic requirements of all the principal vernaculars of India can be served by it and the number of characters may be reduced in order to facilitate general education.

"Modification and simplication of Devanagri is required for greater ease and adaptation of modern printing and publishing, and particularly for linotype machine composition. Consideration should also be given to the adoption of Devanagri for a practical and efficient type-writing machine.

"It was decided at Indore that a tentative scheme should be prepared by a sub-committee consisting of Prof. Lalit Prasad Sukul, Prof. Suniti Chatterjee and Mr. Hori G. Govil. This scheme was prepared by holding half a dozen conferences in Calcutta before Dr. Suniti Chatterjee sailed for Europe to attend the International Congress of Phonetics.

"Mr. Govil's suggestions are based on the principle that no change should, so far as possible, be introduced which may necessitate re-education and which may break the continuity of our literary current and cultural heritage. His scheme, therefore, suggests slight modification in design and shape of our present script and no radical changes which may not be practicable to bring about in the present state of the Indian press and educational system.

"'United Press' understands that the Calcutta Sub-Committee has after due consideration adopted practically without any modification the entire scheme suggested by Mr. Govil and incorporated his scheme in the final report which the sub-committee submitted for the consideration of the full committee meeting at Wardha on June 25. 'United Press' also understands that the new types suggested by Mr. Govil will be ready for demonstration within a month or so when the public and the press will be able to fully realise the true significance of the whole scheme and the economy and ease which may be introduced in printing and publishing business."

In view of the great importance of the problem for the future cultural union of the different provinces of India, the "Science and Culture" invites further discussion on the subject from those who have studied the problem. It is circulating an enquiry to the experts and the representative men of the country representing all the vernaculars, inviting their opinion on the suitability of the adoption of the Roman or the modified Devanagri script for all the vernaculars of India. Their opinions when received will be published in the 'Science and Culture'.

A Century of Progress in Scientific Thought

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The century from 1830 to 1930 has witnessed such great progress in scientific achievements that human civilization has practically changed beyond recognition in all advanced countries. I was reading an article sometime ago in the *Sunday Statesman*, comparing modern life with that of the early Victorian era in England; railway trains had just come into existence, but not the fast mails running at the rate of 75 miles an hour, with which we are familiar today. Faraday was then just beginning his experiments on electro-magnetic induction, which was ultimately to form the basis of electrical engineering, and the methods of electrical transport. Sadi Carnot had just discovered the principle, according to which flow of heat from a higher to a lower temperature can be made to yield work, but the invention of internal combustion engines, and all that it meant for the development of motor cars and aeroplanes was yet a dream. If the transport arrangements were crude, the methods for the communication of news were almost primitive. You are all, perhaps, familiar with the story how the foundation of the great Banking House of Rothschild was laid on speculations based on the early receipt of news about the victory of Waterloo by special messengers. Contrast that with the modern telegraph, or telephone, which makes it possible for a man living in Calcutta to communicate with his friend in London; and then the wonder of the age, the wireless broadcasting, which not satisfied with sending out news and musical programmes to all parts of the world, makes it possible for an august personage at Melbourne to launch a vessel at Glasgow; and it will be no wonder if in the next war Berlin is bombarded by aeroplanes controlled by an operator in the air office at London! Intense investigations on problems of television are now in progress, and, here too, it is almost certain that a decade hence, a Test Match in London will be witnessed with greater ease in a cinema hall in India than in the actual playing field. Side by side with the progress in communication and transport, new sources of power have been discovered and harnessed for our use. Billion times more coal are used in our industries today, and oil and water which have run to waste for millions of years, are competing with coal as sources of power. Pipe lines containing oil now run from Mosul to the Mediterranean, from the shores of the Caspian Sea to the Persian Gulf, from Upper Assam to Chittagong, from Upper Burma to Rangoon, and from the Alleghany Mountains to the Pacific coast, with the result that great powers who could not accept mandate for America are only too anxious to take to mandate for Mosul.

The metallurgical industries have advanced hand in hand; as in the case of coal, billion times more steel, and newer and better types of it, are being produced today. Metallic aluminium which was unknown a century ago, has now become one of the commonest articles of use, and the new alloys, duralumin, and magnelium which combine the strength of steel with the lightness of aluminium, have made possible the manufacture of airships and aeroplanes.

The advance in chemical industries has been no less phenomenal. Cotton textiles and dyes, woolens and artificial silks, soaps, leather, glass, earthenware, paints and varnishes, paper and ink, rubber goods and appliances, are now being produced in quantities and by methods which no H. G. Wells of the early Victorian age would have dreamt of.

In America, in Java, and in some parts of Europe, progress in agriculture and animal breeding has been as spectacular. New methods of cultivation make it possible for a farmer with an average family of four to manage 400 acres of land. Application of artificial manures, synthesised by new chemical methods, has increased the yield thrice or four times; and the plant breeder has produced new

types of seeds for wheat, rice, barley, oils, which have higher yielding capacities and better food values and are more resistant to disease. Cattle have been so bred that it is a common sight for a visitor in Denmark to find a cow yielding 80 pounds of milk a day at the age of three for eleven months in the year. Such a cow was also bred in the Dairy Institute at Bangalore, and Mahatma Gandhi wrote down in the Visitors' Book that if the British Government could provide one such cow in every Indian village, he would call the Government angelic rather than satanic.

It may interest you to learn of a great piece of Indian work on plant breeding. Barber and Venkataraman discovered that the sugarcane can be made to flower at Coimbatore, and yield seeds. By methods of cross-breeding with sorghum new types of sugarcane have been brought into existence which remain in the field for five months instead of ten for the usual variety, The Dutch planters in Java were suffering immense losses due to a mosaic rust disease in their sugarcane plantations, and they invited a Dutch botanist to breed for them a new type of sugarcane, resistant to this disease. Five years of work in the laboratory led to the development of a cross between sorghum and cane, which is as hardy as the wild sorghum, and contains as much sugar as the best cane; and the Java plantations which were threatened with extinction could dump white sugar in India at Rs. 3-8-0 per md.

New methods of biological control of insect pests have also been devised which have been of immense benefit to agriculture. Let me give an example. On the Island of Fiji, cocoanuts have for sometimes been staple products. Some decades ago, the plantations on one of the main islands were reduced to nutless leafless poles. That was bad enough; but then after the war, the plague began to appear on the main island. The scientific men are still active, who brought prosperity to Fiji. It had already been discovered that the cause of the trouble was a little moth, very beautiful with violet wings, whose grub devoured the leaves of the cocoanut palms; and it multiplied so alarmingly in Fiji, because it had no parasite enemies. Three biologists were appointed to find out a friendly parasite. They searched all the four corners of the Pacific. At last they found one in the Malay States, the moth of a closely related species which has its natural local complement of parasites—a kind of fly which feeds on these moths. It was not easy to bring these flies all the distance from Malay to Fiji, and a special steamer had to be chartered, in which 300 precious parasitic flies were kept in cages and regularly fed with moths which are their chief article of diet. These moths in their turn had to be cultivated and multiplied, by providing them with newly sprouted cocoanuts and cocoanut leaves throughout the voyage. By these means, these precious flies were at last landed in Fiji in 1925. These were bred and multiplied by feeding them with the cocoa-nut moths of Fiji, and by 1926 the three hundred increased to thirty thousand. Then the liberation of these parasitic flies began, and they went to their work with such gusto that by 1929 the cocoanut moth which threatened to ruin the archipelago, had become reduced to a status of a very minor nuisance. The islands of the Pacific and the Indian Ocean are now flourishing plantations, where cocoanuts are grown in such abundance that the world price of cocoanut products is a quarter of what it was in 1929. In Calcutta port alone, 5 million gallons of cocoanut oil were imported in 1933-34 at the incredibly low price of Rs 7/- per md.; the ryot of South India whose chief source of income was his small cocoanut garden has been very hard hit—much harder even than the jute growers of Bengal, and the Imperial Council of Agricultural Research are now considering the enactment of suitable measures for their protection. Measures of protection can however only be palliative. The only bed-rock on which lasting prosperity can be built is the continuous application of scientific principles and methods, as they are discovered, to problems of industry and agriculture. A nation, which fails to do so, is destined to be pushed to the background. In advanced countries, diseases which have been the terror of the ages, have been practically eliminated. Plague, cholera, smallpox, typhoid, kalaazar and malaria, which still take their toll of millions of men in India, have been completely brought under control in Europe and North America so that the average expectation of life in those countries has increased from 25 to 55 in course of a century. The methods of control are known, but in India unfortunately we lack the organisation and the will-power in the people to live better, and

hence scientific knowledge has not been effective in transforming the conditions of our life.

The pioneering work of the great Frenchman Pasteur gave birth to the new science of bacteriology; and biochemists have ever since been busy, making sera, vaccines, and synthetic drugs which are specific antidotes of those micro-organisms which are harmful to men and animals; and they have been eminently successful. Sir Upendra Nath Brahmachari's *urea stibamine* which has proved almost an infallible specific against kalaazar is a striking example of the success of biochemical research against a great human scourge. In the domain of surgery, the advance has been no less striking. The horrible sights of men groaning under agony and held down in chains while being operated upon, and then dying in 90 cases out of 100 due to septicaemia following the operation, are now matters of forgotten history. The great Simpson in Edinburgh, experimented upon himself the effect of drugs which create temporary anaesthesia, and in 1843 perfected the technique for using chloroform; and within the decade 1860-70 his great colleague at Glasgow, Lister, influenced by the discoveries and writings of Pasteur, invented processes for operations under antiseptic conditions, which brought down the mortality figures to 10 out of 100.

Operations in the brain have now become a common feature in American hospitals, and during the Great War bold surgeons were not wanting, who would extract a bullet from an outlying portion of the heart, and that too with success.

I have so long talked of science, as it has affected the standard of living. We may now proceed to ask the more fundamental question, "What is it in this external world that is necessary to sustain the process of life?" The answer of physico-chemical science is that there must exist in the external environment energy that is not in equilibrium—energy which can be made available for performing work. An animal is like an engine which liberates the potential energy of the food it takes by combustion in oxygen which it inhales and transforms it into heat and work. The principal source of energy available on the earth is derived from the radiation of the sun, which is therefore the great sustainer of life. "I take off my hat to the worshippers of the Sun. Equally I take off my hat to the farmers; they are the shepherds of light, and priests in the Radiant Temple of the Sun".

It is the green plants that "bottle the sunshine" *i. e.* convert a part of the radiant energy that falls on them into potential chemical energy. These plants contain several pigments, the chief of which is the green colouring matter called chlorophyll. By means of these substances, and under the influence of light, the living green plants are able to convert the carbon dioxide and water vapour in the atmosphere into sugar and oxygen—

$$6\ CO_2 + 6\ H_2O + 674{,}000\ \text{cal} \longrightarrow C_6H_{12}O_6 + 6\ O_2.$$

Energy of Sunlight

Under normal conditions, the reverse reaction takes place, *i. e.* sugar can be made to burn in oxygen producing heat and work. The great merit of this process therefore lies in the fact that the radiant energy of the sun is stored up as chemical energy in the sugar molecule. The green plants are therefore the fundamental capitalists of our world. Animals live on this capitalised energy stored up by the plants. If it were not for the capital stored up by these silent green accumulators of potential energy, the generous sunshine would run to waste, and life on this plant would probably come to an end. We may next ask ourselves the question: "How efficient is this process of transformation, *i. e.* what reaction of the radiant energy is converted into potential chemical energy?" Recent researches of Prof. Warburg in Berlin-Dahlem have given a satisfactory answer to this question. Sunlight as you know is a mixture of different sorts of radiation corresponding to the various colours of the spectrum. Working with a minute green algae called *Clorilla* Warburg showed that the efficiency increases as we pass from the blue region to the red region of the spectrum from 35% to 60%. The award of the Nobel Prize to Warburg was a fitting recognition of the merit of his work.

Let us pause for a moment to consider this fundamental process from another point of view. The energy radiated to us by the sun comes from its surface layer. An analysis of this radiant

energy shows that the temperature of the surface layer must be about 6000° C. The average temperature of the earth's surface is only 30° C. The conditions are therefore such that the relatively cool surface of the earth is, during daylight, bathed in a stream of relatively high temperature light. Here then we have another case of energy out of equilibrium, and hence the possibility of a partial transformation of this energy into potential energy. If the surface of the earth is entirely deprived of this bath of high temperature radiation of the sun, the possibility of storage of chemical energy by green plants would disappear, and life as we know it would come to an end. The sun is the life sustainer, because his surface is sufficiently but not too hot, and because we are far away enough from him to be sufficiently but not too cool.

Let us now turn from the affairs of living beings, from science applied to our needs, to the problem of science itself. The two great discoveries on which modern science is built up are the Laws of Conservation of Matter and of Conservation of Energy, according to which the sum total of matter in the universe is constant and the sum total of energy in the universe is also constant. The discovery of the laws was the greatest achievement of science before the dawn of this century.

We now find however that the interaction of radiant energy and matter is of a very intimate nature, and that radiant energy has got the attributes of matter in some respects and *vice-versa*. A very large part of modern physico-chemical science has been concerned during the last thirty years with an intensive study of this interplay of matter and radiation. A simple example may help us to understand at least a part of this interaction. If we pass an electric discharge through the vapour of mercury, the atoms of the mercury are stimulated by the absorption of energy, and in subsequently giving out this energy, they emit a beautiful green light. If we now allow this light from mercury vapour to enter a suitable vessel containing besides water vapour and oxygen gas, a little mercury vapour, we obtain a substance called hydrogen peroxide which contains more chemical energy than water and oxygen from which it is built up. What happens in this case is well understood. The atoms of mercury in the reaction tube absorb the light which is emitted by the mercury arc, and these energized atoms of mercury pass on their excess energy by collision to molecules of water and oxygen, and thus hydrogen peroxide is produced.

What happens, then, when matter is raised to high temperature, or stimulated by absorption of radiant energy? If you go to a foundry or a forge, you see masses of metal heated to a high temperature. The metal shines and gives forth radiation. The tungsten spiral in the electric bulb does the same trick, only it is heated by electric energy. By day our steps are guided by the light coming from the sun, by night we see radiation coming from matter raised by ourselves to high temperatures. We thus arrive at the conclusion that atoms and molecules can become storehouses of potential energy by the absorption of radiation; and such energy-rich molecules or atoms can in turn emit radiation and revert to their normal condition. How far can this process go?

Experimental evidences of an unimpeachable character have now convinced us that the nineteenth century division of matter into 92 fundamental unchangeable units or elements is untenable and that all atoms are built of some identical units, which we now call electrons, protons, and positrons. You are probably familiar with the meaning of these terms—an electron is the ultimate unit of negative electricity; a positron is the ultimate unit of positive electricity; and the proton is the unit of mass associated with the ultimate unit of positive electricity. The atomic structure resembles planetary systems with the mass and positive electricity concentrated at the centre, and the electrons moving about in planetary orbits. All the 92 atoms are built on the same model, the positive electricity and mass at the central nucleus and the outlying planetary electrons increasing as we pass from hydrogen to uranium. This is one of the most revolutionary concepts of modern times—matter is ultimately built of the ultimate units of positive and negative electricity. The electron and the positron have inertia which is the characteristic of material particles, and their masses are of the order of a thousandth of a hydrogen atom. These material attributes of electrical units have now been

extended to radiant energy itself. It has been shown experimentally that radiation exerts a pressure on the surface on which it falls; in fact, the properties of an enclosure containing radiation whose energy is equal to E ergs, can be explained on the concept that the mass of this radiation is E/c^2 grams, c being the velocity of light. If V be the volume of this enclosure, we can conceive of radiation as being equivalent to a perfect gas occupying this space, and the density of radiation is therefore given by E/Vc^2. Matter and radiant energy are thus inter-related in the sense that we can state numerically the energy corresponding to the mass of a given piece of matter and the mass corresponding to the energy of a given quantity of radiation.

Now we shall embark on a flight of human imagination than which nothing more daring has ever been attempted. It relates to the most fundamental type of chemical action which the human mind has yet conceived. It is a question, in fact, of the possible birth of matter. One of the most difficult problems of astrophysics is to account for the source of energy of the stars. Our own sun is reckoned to be thousands of millions years old. What is the source of radiant energy which the sun continuously pours forth? In the past history of astronomy, seven theories have been advanced to explain this amazing phenomenon, but all have been proved to be inadequate. Some thirty years ago, Sir James Jeans made a daring and fertile suggestion, in fact one of the most brilliant and original that have ever been made. Energy is derived from the annihilation of matter; matter disappears as such and is transformed into radiant energy. How can such a thing be possible? The surface layer of the sun has a temperature of about 6000° C. We have no reason, however, to suspect that at temperatures of this order of magnitude, there is any possibility for the annihilation of matter. The investigations of modern astrophysicists have however led to the conclusion that the interior of the stars must possess temperatures incomparably higher than those corresponding to their general surface radiation. We must reckon the temperatures of stellar interiors not in millions, but in thousands of millions of degrees. At such gigantic temperatures, as Prof. Saha has proved conclusively, matter must certainly become pulverized, *i. e.* the atoms of matter must be broken up almost entirely into their constituent units, the protons and the electrons. The beginning of such process can be detected at temperatures available at our laboratories. At the very high temperature of stellar interior matter exists in a much simplified state, but it is still matter. For example, it would be subject to the law of gravitation. Energy is thus required to break matter up into its simpler constituents. What then is the source of energy of the star? Jeans writes the devastating equation :—

Proton + Electron —> Radiation or Radiant Energy.

This is revolution in thought. It is not an ordinary chemical equation, since there is no matter in the ordinary sense on the right hand side. It is not an energy equation in the ordinary sense, since there is only matter on the left hand side. It violates the old Law of Conservation of Matter, and it appears to violate the Principle of Conservation of Energy. Now suppose the action represented by this equation is reversible, *i. e.* it can go in both directions; we indicate that by putting a double arrow. Read from left to right, this equation says that matter vanishes, and is transformed into energy. This is surprising enough, but read the equation from right to left, and what does it say? Radiant energy vanishes, and is transformed into matter—a creation of matter!

Once the idea has taken root, investigations, necessarily of a theoretical nature, were set on foot to find out the conditions under which such transformations become possible. Prof. Milne has made a very detailed calculation of this reversible chemical equilibrium by applying the laws of chemical thermodynamics.

He proves that the active transformation of radiation into matter becomes appreciable only at 10^{11} degrees and the densities of matter and radiation become comparable at 10^{12} degrees; and these are temperatures which are attained in the interior of the stars.

At last, science has imagined a region where the frequent annihilation and rebirth of matter may possibly be the chief activities present, at all events, very prominent ones. It is a region where radiant energy may be as dense and as massive as the

matter present. To our human minds, it is a very terrible region, a veritable pool of glowing fire at a temperature of perhaps a billion degrees. It is something that even Dante could never have conceived. And what do we find? The terrific radiation in the centre of the sun becomes softened in quality as it makes tortuous way from the interior to the surface of the star. Emerging therefrom it becomes further softened as it penetrates our atmosphere, until at last it shines down on us as the radiance that sustains our life, the precious breath that gives birth to all the beauty of living forms. What better example could we have, that the universe is one interrelated whole, that the cosmic process is no affair of casual accidents occurring amongst unconnected parts.

A final question remains to be considered. We have seen how matter and radiation can remain at equilibrium in enclosures at 10^{12} degrees. The frequency of vibration of such radiation will be about 10^{22}, which is very much more than the hardest X-ray with which we are familiar. If radiation of such high frequency were to escape into a cool region of space, what would happen? It would certainly possess the power of breaking up matter into its constituent ultimate units. We may also ask the reverse question: to what extent under such circumstances might this very high frequency radiation be able to create matter, *i. e.* proton and electron? The answer to this question must be positive though the efficiency, according to our present day knowledge, must be considered to be low.

Such considerations are by no means idle speculations. One of the most important discoveries of modern times is the detection of high frequency radiations which enter our atmosphere from outer space—the so-called cosmic rays. This type of radiation is evidently distributed throughout interstellar space. Does it arise from the annihilation or the building up of matter? We enter here into one of the most fascinating regions of modern scientific thought—the problem of the Evolution of the Universe. "In the womb of space and time, in the basal metabolism of the Universe, does there exist both building up and breaking down?"

"This bowl of milk, the pitch on yonder jar;
Are strange and far-bound travellers from afar,
This is a snowflake that was once a flame—
The flame was once the fragment of a star."

Is the visible material universe slowly dissolving into a universe of radiation in eternal equilibrium? Or, is the present cosmic process but a passing phase in a universe which oscillates and fluctuates from state to state in which the word equilibrium has no meaning. It is the biggest problem that awaits solution, and we bow down our head in awe and reverence, when we contemplate this problem.*

* Based on a lecture delivered at the Regent Park Hall, Dacca.

Book Review

Life and Experience of a Bengali Chemist—*By Prafulla Chandra Ray. Published by Chuckervertty Chatterjee & Co, Ltd., Calcutta. Price Rs. 5/- Pp. 557.*

Dr. Prafulla Chandra Ray is without doubt one of the makers of modern Bengal. In its varied aspects our national life has come to bear the impress of his rare and versatile genius. As the father of the Indian school of chemistry he has to-day become the doyen of the Chemical Society in India. As the pioneer in chemical manufactures again, he is undoubtedly one of the foremost captains of industry in modern India. During the last half a century, moreover, there never was in the country a movement of national import but had his sympathetic support and unfailing guidance. It is no wonder then that his ascetic life and manifold public activities have made the name Prafulla Chandra a bye-word in Bengali homes. The younger generation, however, constitutes his chief concern. That is why to the youth of India he has dedicated his autobiographical sketch, *Life and Experience of a Bengali Chemist*, so that its perusal may in some measure 'stimulate them to activities'.

If the lives of its heroes be said to constitute a nation's history, this is particularly true of the work before us; inasmuch as Dr. P. C. Ray's career synchronizes exactly with the period of our national awakening. That the author is fully alive to this is evident from the fact that the book has been divided into two parts: (*i*) biographical and (*ii*) historical. The latter gives an insight into the educational, industrial, economic, and social forces at work during the period.

Auto-biographies of successful men are always a fascinating study, and to this Dr. Ray's is no exception. The simple narrative of his early life in village surroundings and of a promising career, despite failing health, in schools and colleges at Calcutta has a charm all its own. It shows how unlike the generality of students, he was even as a boy a voracious reader and kept up extra-scholastic associations. From his boyhood he came under the influence of the Brahmo Samaj and was a regular attendant to Keshav Chandra Sen's sermons on Sunday evenings and to his public addresses. Thus he imbibed early a strong nationalistic bend of mind, to which his 'Essay on India' bears eloquent testimony.

But his patriotic impulse was to bear fruit in spheres far other than public platform or the press, although his writings and speeches are in themselves of no mean order. His genius was essentially of a constructive nature and he was destined to outdo his peers in the work of nation-building. With a decisive scientific bend of mind Dr. Prafulla Chandra became, so to say, wedded to Chemistry since the securing of the Edinburgh Doctorate in 1885. At the beginning of his career we find the young professor in the Presidency College Laboratory deeply engrossed in various researches on food-stuffs, *viz*. ghee and mustard oil, so as to improve the dietary of his countrymen. But those of his original researches which elicited the unstinted praise of the entire chemical world were in connection with the nitrites. For he it was who had showed for the first time, contrary to text books, that ammonium nitrite could be attained in a stable crystalline condition and volatilized.

What, however, constituted his greatest service is the creation of the Indian school of chemists. Messrs. Jnanendra Chandra Ghose, Satyendra Nath Bose, Megh Nad Saha, Rasik Lal Dutta—to name but a few of his pupils—form a galaxy of whom any teacher has reasons to feel proud. Prof. Sylvian Levi rightly observed, "His (Dr. Ray's) laboratory is the nursery from which issue forth the young chemists of New India". Ancient India was, however, far famed for her knowledge of chemistry,

and Prafulla Chandra's investigations in this connection resulted in the compilation of the *History of Hindu Chemistry*. It need hardly be mentioned that the treatise forms an important contribution to scientific literature.

The *Life and Experience of a Bengali Chemist* cannot however, be complete without a reference to the Bengal Chemical and Pharmaceutical Works. The illustrious author has, therefore, given a detailed account of its origin and growth. The idealism of the young industrialist, the hopes and fears of his ventures, and the steady progress, despite occasional mischance—all these reflect the charm of a veritable romance. But the bull-dog's tenacity of purpose, singleness of devotion and incessant toil that the success of the venture meant for the pioneer are writ large everywhere.

Interspersed throughout the biographical chapters as well as the subsequent ones, dealing with the social problems, one would come across repeated reference to the principles of life and society, which Profulla Chandra has made his mission to inculcate on the Young Bengal, in particular. There is thus the usual tirade against the craze for higher education and the mad rush for service hunting among the middle classes, to the neglect of the demands of the country's trade and industry. This has been the cause of the growing exploitation and the increasing poverty of the children of the soil. The fissiparous tendency inherent in our social organization based on caste barriers has also, according to the author, its share of our undoing.

With regard to reflections of this kind by masterly array of facts and figures the author has attempted to make his position unassailable. The book is on the whole very illuminating. It is written in the author's characteristic simple style. The inexhaustible fund of materials and the richness of quotations that the author has liberally drawn upon to bring home his view points, constitute at once the strength as well as the weakness of the book. The extent to which some points have been laboured is not without its effect upon the merit of the book. The author himself does not seem to be unware of the disjointed nature of his work and ascribes it to its different portions being written at different times after considerable intervals. In the second volume, which, we presume, is now in the press, we would expect from the illustrious author a systematic account of his times, with the history being recast and re-made before his eyes.

The World as I see It—*By Albert Einstein, (John Lane: The Bodley Head), 8/6.*

Einstein is not only a great scientist, but a humanist also; and his sacrifices for the realization of the aspirations of his race, as well as for the ideals of peace and dignity of man, are no less notable than his contributions to knowledge. But these ideals are not acceptable to the militant nationalists of the day, and in consequence Einstein is now misunderstood in his adopted country where his presence and example were the inspiration of innumerable scientific workers. The present book is, therefore, opportune and will help its readers to appreciate the man, his motives and his attitude towards life. *The World as I see It* is, however, not a connected philosophical treatise, but a selection of Einstein's papers, letters and addresses, touching almost all the questions which have interested him during the last twenty years. In such a collection some amount of scrappiness and occasionalism is inevitable. Yet the personality which strings them together is so clear in its outlines that in spite of the apparent contradictions the essays have no room for mis-interpretations.

The book is divided into five parts, of which the first four deal with non-scientific topics, ranging from obituaries of his friends to protests against militarism and political oppression, interspersed with touches of humour and personal reminiscences. Though these writings are interesting, yet they are rather ephemeral by nature; and the main value of the book resides in the fifth part which occupies almost half the volume and deals with his scientific philosophy. Einstein states here his position as a theoretical physicist and his hopes about the future of science. On the face of it, he is inclined to take a Kantian view of scientific knowledge. For he states that no amount of analytical reasoning would lead us from experiments to formulation of universal laws which, according to him, are only revealed in a mysterious way to the seeker whose "cosmic religious feelings" urge him to escape from "the

everyday life with its painful crudity and hopeless dreariness" to "the universe of objective perception and thought" which he wants to "experience as a single significant whole."

Although the successes of the new quantum mechanics have made many scientists sceptical of the law of causality with all its implications, yet Einstein would still echo Schopenhauer and maintain that "a man can do as he will, but not will as he will." He believes in the existence of an "unambiguous system of essential principles" determining the world of phenomena. "Nature," he thinks, "is the realization of the simplest conceivable mathematical ideas." He is convinced that the concepts and the connecting relations which furnish "the key to the understanding of natural phenomena can be discovered by purely mathematical constructions." Though "the mathematical propositions arrived at by logical means are completely empty as regards reality," the human intellect can intuitively supply the empirical content and thus arrive at a valid representation of the external world by ceaseless endeavour and comparison of the model with the world of experience.

Einstein has tried to justify the above attitude by analysing the methods which led to the discovery of the Generalized Theory of Relativity. He has, also, referred to the attempts he is making to arrive at a higher synthesis which will bridge the present chasm between the field theories with their determinism and partial differential equations and the quantum theory with its probabilities and matrix methods. For his faith in mathematics and deduction remains unshaken. Though experience is the touchstone of the physical utility of a mathematical construction, yet, for him, "the creative principle resides in mathematics," and in a certain sense it is possible for "pure thought to grasp reality as the ancients dreamed."

S. N. B. & S. N. D.

Electron (+ and −), Protons, Photons, Neutrons and Cosmic Rays.—*By Robert A. Millikan. Pp. 492. University of Chicago Press, 1935. Price $3.50. Cambridge University Press, 1935. Price 15s.*

This is the second edition of Millikan's famous little book "*The Electron*", which was published in 1917 and was acclaimed almost as a classic by physicists everywhere. This edition is nearly double the size of the old book, the first half being essentially the same old work, while the remaining portion gives a full and up-to-date account of the experimental discoveries of the new fundamental particles made within recent years.

The first half of the book contains an account of experiments to prove the atomicity of electricity and the author's measurement of this elementary charge. In addition to the discussion of this elementary charge, the earlier chapters contain older views regarding electricity, the extension of the electrolytic laws to conduction in gases, the mechanism of the ionization of gases by X-rays and radium rays, Brownian movement in gases, the evidence about the non-divisibility of the electron, the structure of the atom and the nature of radiant energy. Few changes have been, and needed to be, made in this part, in the present edition. Here and there short references have been made about more recent works, *e.g.*, on ion mobility and determination of e/m for electrons, and in the chapter on exact evaluation of e the only revision made is that the value of e is now given as $4.770 \pm .005 \times 10^{-10}$ absolute *e.s.u.* in place of $e = 4.774 \pm .005 \times 10^{-10}$ old international *e.s.u.*, this being due to later determinations of both e and the ohm. The author has devoted some thirty pages to the disproof of Ehrenhaft's hypothesis of the sub-electron. In view of the fact that the sub-electron theory finds no credence amongst scientists at present, the attempt looks like flogging a dead horse, and it would have been better if the reader were spared these long thirty pages. In contrast to this, it is remarkable indeed, that the author has taken no notice of the recent determination of e from purely X-ray data, by Bäcklin and others of the Upsala laboratory, which gives a slightly different value for the elementary charge, and throws doubt on the accuracy claimed by Millikan.

In connection with atomic structure discussions, the Bohr atom was taken as the correct picture in the older work and in the present edition too, Bohr's theory has been enthusiastically elaborated, and even some pictures of atom models showing interlacing

circular and elliptical orbits of electrons are given as illustrations, though the author has concluded the discussions with the significant remark : "However, all mechanical pictures like the foregoing, while useful as mnemonic devices have definite limitations and must not be thought of as corresponding in any way to reality." A new chapter on "Spinning electron" gives a historical survey of how the limitations of Sommerfeld's relativistic interpretation of fine structure led to postulation of the spinning electron hypothesis and thence to the interpretation of the new spectroscopic rules developed by Russel, Pauli, Hund etc. The significance of Compton effect has been discussed in relation to the nature of radiant energy and reference has also been made to du Mond's work on the width of Compton shifted line. The apparent contradiction that "particles actually are found experimentally to behave like waves and waves to act like particles" has been tried to be reconciled in the light of developments in wave mechanics.

The succeeding chapters give a historical survey, though somewhat greater emphasis has been laid on Millikan's own work and that of his associates, of the discovery and investigations of cosmic rays, the positive electron and the neutron. The origin of cosmic ray showers has been discussed and a full account of researches in artificial radio-activity has also been given. The pair creation theory of Dirac and the annihilation of the positive electron has been dealt with in the light of experimental observations. The discovery of the neutron, its nature and the question of proton *vs.* neutron as the fundamental entity, have been discussed at some length. The last fifty pages of the book embody essentially Millikan's own work and views on the nature of cosmic rays, and must not be accepted as a well-balanced report, proper attention having not been paid to the rest of recent progress in the same line.

It is well-known that the technic of cosmic ray investigations which ultimately led to the discovery of the positron was started by the Russian worker Skobelzyn, who narrowly missed the discovery ; in fact, as an eminent scientist said, the failure was due to his bad eye-sight. About the discovery of the positron by C. D. Anderson, it has been said that like Saul in the Bible, he went in search of his father's asses and found a kingdom *viz.* discovered the positive electron. It is therefore surprising to find that Skobelzyn should be dismissed with a passing reference in an obscure footnote, and that too, not in a very complimentary way. It also cannot escape one's notice that rather scant recognition has been given to the work of Dirac, whose brilliant and inspired mathematics led to the deduction of the existence of the positron, but for which the discovery of the same might have waited indefinitely.

The book is written in a simple, almost popular style. The text avoids mathematics, stress being always laid on the underlying physical ideas ; a few important calculations and data have been included in appendices. A great number of illuminating and illustrative photographs form an excellent feature of the book. The rather frequent mention of the Norman Bridge laboratory in particular and the work of American scientists in general, is probably meant to serve as an inspiration to the rising generation of American physicists.

On the whole the volume may be recommended both to scientific experts and the scientific public as an inspiring and accurate account of an important field of physical research, opened up in recent years, in which the author and his associates took a leading part.

S. Datta.

The March towards Absolute Zero

M. N. Saha

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A hundred and fifty years ago, the lowest temperature in the conception of man was probably that of ice. About this time Fahrenheit showed that by mixing ice with common salt crystals and vigorously stirring the mixture, much lower temperatures could be produced. In fact the thread of the mercury column sank 32 points on his scale below that of melting ice.

During the middle of the nineteenth century, our knowledge of heat phenomenon which was previously confined to gas laws, was further enhanced by a clear formulation of the principles of thermodynamics. These laws told us that we can go 273 degrees on the scale of Celsius below the temperature of ice, when we shall reach a stage which is called the absolute zero of temperature. (The Absolute Null point A.N.) We cannot have anything colder than a substance at this temperature, but ideas were not quite clear as to what was exactly the mechanical picture of a material body at the A. N. If a gas followed the so-called law of perfect gases, its volume would become zero at this temperature. But this is mere speculation, and we have not to face this situation because it was confidently expected that long before this temperature was reached, all gases would become liquid or solid and cease to obey the law of perfect gases. But even the properties of solids at this state were expected to be quite interesting; a very intense effort was therefore made to reach temperatures as low as possible.

The story of all these endeavours for reaching lower temperatures can be found in any text book on physics. From simple laboratory experiments, the methods invented by the successive bands of workers passed into industry and have given us refrigerators, machines for cheap manufacture of ice and *dry ice* (solid carbondioxide) and plants for the manufacture of air in the liquid form. Millions of people are getting employment in the new industries opened by low temperature research and methods have been perfected for the preservation of food stuffs, which have created a revolution in the problem of food supply for the world. As illustrations, we may say that of the food which an Englishman usually takes, the meat comes from distant Australia and Argentina preserved in frigidaires within the holds of ships, most of the fruits come similarly preserved from West Indies and the United States and India.

Work of the Cryogenic Laboratory, Leyden, Holland

Upto the year 1908 the only material substance which resisted liquefaction was helium. In that year, it was liquefied by Prof. Kammerlingh Onnes of Leyden in his famous cryogenic laboratory. With this spectacular culmination of a long series of works, it appeared that low temperature research had reached a rather dull and academic stage, when nothing very important was expected to be discovered. Prof. Onnes had, however, shown that the temperature of boiling helium was 5.2° K (K denotes Kelvin or Absolute Scale), and could reach lower temperature by allowing helium to boil under reduced pressure, but inspite of all his efforts he did not succeed in getting helium, solidified. This was achieved after Prof. Onnes' death by his successor, Dr. Keesom, by the application of pressure to liquid helium.

Discovery of Super-conductivity

About this time the interest in the subject was revived by two capital discoveries: the first was Kammerlingh Onnes' own discovery of the phenomenon of super-conductivity. Onnes found that when a coil of lead was placed within liquid helium bath, its electrical resistance was reduced at least a million times. This was very strikingly shown by repeating the ordinary experiments on electro-magnetic induction with the coil of lead within the liquid helium bath. Every school boy

knows that if a magnet is brought before a coil, a momentary current is induced, but it dies out within the hundredth of a second. The mechanism of this phenomenon may be thus expressed. Sudden variation of the magnetic field sets the electrons in the coil in motion, but on account of electrical resistance of the coil, they are immediately brought to rest. If we take a large coil, as for example the coil in a large motor, the time taken by the induced current to die down increases, and the period of growth can be measured by an ordinary stop watch. We may explain it by saying that now the total inertia of the electrons is much larger. The inertia depends entirely on the dimensions of the coil. Kammerlingh Onnes found that if a magnet is brought in the neighbourhood of a lead coil kept within liquid helium, the induced current persists not for a few seconds, but for days together. But this cannot be due to an increase in the inertia of the electrons, as this quantity depends entirely upon the geometry of the coil, so that the only explanation is that the resistance has dropped a million times. The coil thus becomes a permanent magnet.

The discovery of the phenomenon of super-conductivity roused great interest in low temperature work. Upto the present time, about twelve elements have been found to pass to the super-conducting stage at liquid helium temperatures. Niobium has been found to be super-conducting at the highest temperature so far investigated (12°K Kelvin or Absolute scale). But good conductors like copper or silver have not so far been found to show super-conductivity even at a temperature of 0·7°K. Certain compounds like ZnS and some carbides which are usually semi-conducting have been found to pass to the super-conducting state at liquid helium temperatures.

The Nernst Heat Theorem

The other great event which stimulated research in this region was the postulation by Prof. Nernst of his famous 'Heat Theorem.' It is rather difficult to give in plain language the full significance of this theorem. We may say that it attempted to define the properties of solid bodies at the absolute null point. It is defined in the form due to Planck, that at the A. N., the entropy of all material bodies at condensed phase (solid or liquid) tends to the value zero. Now entropy, according to statistical interpretation of thermodynamics, measures the degree of disorder amongst the particles composing a material body. The Nernst Heat Theorem, therefore, says that at absolute zero there will be perfect order amongst the particles composing a substance. And it further says that such a stage is unattainable, because otherwise one should be able to convert all heat energy into work. We could thus achieve perpetual motion of the second kind (continuous conversion of heat into work).

There have been very hot debates in the past as to whether the Nernst Heat Theorem is absolutely correct or what should be the proper way of its formulation. The controversy is not yet at an end; but it stimulated great activity in low temperature research. Nernst himself pointed out that, according to his theory, specific heat of all substances should tend to zero in this region, and in collaboration with his students he planned a series of experimental work in which this prediction was brilliantly verified. But it became apparent that such investigations should be carried out at much lower temperatures.

The Liquid Helium Plants in the World

Low temperature work at Leyden was further continued by Keesom and de Haas, successors of Kammerlingh Onnes. They allowed liquid helium to boil under reduced pressure and used a very powerful battery of pumps to remove the vapour and accelerate the rate of evaporation. But they found it impossible to reach closer to the absolute null point than 7°K. It may be mentioned here that the difficulty of reaching absolute zero increases in geometrical progression, that is to say, it is as difficult to reach from 100°K to 10°K, as it is from 10° to 1° or from 1 to one tenth of a degree. For a long time, work in the helium region, below 10°K, was entirely confined to Leyden. At present a few more centres have been developed. Germany has got a fine liquid helium plant at the Physikalische Reichsanstalt, Berlin, under the able guidance of Dr. Meissner. Prof. J. C. McLennan at Toronto, Canada, constructed a liquid helium plant some years ago, which is being worked by his successor, Dr.

Barton. The Cavendish Laboratory at Cambridge has got a liquid helium plant of an entirely new pattern constructed by Prof. Kapitza. The older plants worked on the principle of cascades; that is, low temperature baths consisting of liquid air and liquid hydrogen were successively used, and helium was cooled to liquid hydrogen temperature before it was allowed to expand according to Joule-Thompson method invented by Claude and Heylandt for liquefaction of air, and with rare ingenuity adapted it for the liquefaction of helium. Prof. Kapitza expected to investigate the properties of metals which are cooled to absolute zero, and at the same time, are subjected to huge magnetic fields, but his work was interrupted for reasons published in the June issue of *Science and Culture*. Mention must also be made of a liquid helium plant constructed for Oxford University by Dr. Simon, an ex-student of Prof. Nernst and a political refugee from Germany. This utilizes the phenomenon of cooling by desorption of gases which are adsorbed by cocoanut charcoal or similar substance at liquid helium temperatures. The desorption is effected by rapid pumping. The sixth liquid helium plant is at the Norman Bridge Laboratory at California under Dr. Giaque. With none of these plants it was possible to go beyond 7°K when simply the process of rapid cooling by evaporation was attempted.

Cooling by Adiabatic Demagnetization

In 1926 and 1927, Debye in Leipzig, and Giaque in California independently suggested a new method for pushing towards the absolute zero. This is the method of adiabatic demagnetization of paramagnetic salts. It is well-known that salts of transitional groups of elements like iron and the rare earth metals like gadolinium are strongly paramagnetic. According to a well-known theory of Prof. Langevin, a crystal of such a substance, say $FeCl_2$, may be regarded as consisting of positively charged ions of the metal (Fe^{++} in this case), and negatively charged halogen or similar ion. The negative ion is magnetically neutral, but the positive ion is strongly magnetic. So the crystal may be said to consist of a number of atomic magnets arranged in a regular order. Generally on account of thermal motion these ions are haphazardly arranged. But if the salt is placed in a strongly magnetic field, the ionic magnets will more or less place themselves parallel to the field or in certain other favoured directions given by quantum mechanics. Thus order will be produced. In producing this order some work is done by the ions, which is converted into heat. But on account of contact with the liquid helium bath, this heat is dissipated and the crystal takes the same temperature as the bath (say 4°K). If now the crystal be insulated and the magnetic field be suddenly switched off, the atomic magnets will revert back to the disordered state, and temperature will be lowered. Keesom and de Haas used the large magnet in the Leyden Laboratory, and were able to reach with salts of certain rare earths extremely low temperatures. They now announce that they are able to reach a temperature which is only $\frac{1}{250}$th of a degree from the Absolute Null-point. But it must be admitted that measurement of temperatures in this region is extremely uncertain. Such an achievement is not a violation of the Nernst Heat Theorem which is said to rest on the principle of Unattainability of the Absolute Null-point. We are in the unfortunate position of the man who lent money to a party on condition that every day he will get half of the dues which are still remaining. But though theoretically we may not reach absolute zero, we have reached so far near it that our dream may be said to have been fulfilled. Very interesting properties are shown by bodies at this temperature, but that may form the subject-matter of another article.

The Pre-Vindhyan Geology of Rajputana

In a memoir with the above title, published in the first volume of the *Transactions of the National Institute of Sciences*, India, Dr. Heron, superintendent of the Geological Survey of India, gives a summary of the geology of the oldest rocks of Rajputana, the geological survey of which has been carried out during the course of the past 27 years by Dr. Heron and his colleagues, Drs. A. L. Coulson, P. K. Ghosh, L. A. N. Iyer, and Messrs. J. B. Auden and B. C. Gupta. Detailed descriptions of large portions of the area in question have been published in the Memoirs of the Geological Survey of India, whilst other memoirs dealing with the remaining parts of the Agency are in the course of preparation. Previous workers in these regions include Messrs. T. D. La Touche and C. S. Middlemiss.

Rajputana can be divided geologically and physiographically into four regions :—

I. In the east the Vindhyan plateau and the little altered Archæans in the neighbourhood of the Great Boundary Fault. The Deccan trap of Malwa just enters the south-east corner of the province.

II. The central plain of Aravallis and pre-Aravalli gneisses.

III. The hilly belt occupied largely by the synclinorium of the Delhi system.

IV. The sandy western plains with scattered outliers of the Malani volcanics, Vindhyans, Mesozoics, and Eocene resting on an almost entirely concealed basement of Aravallis and gneiss.

The geological sequence includes :—

(1) Alluvium, (2) Deccan trap, (3) Malani volcanics and Jalor-Siwena granites, (4) Vindhyan system, (5) Erinpura granite, (6) Delhi system, (7) Raialo series, (8) Aravalli system, (9) Pre-Aravalli rocks.

Excepting the Recent and sub-Recent alluvial deposits (1) that include the wide stretches of desert sand of the north-western parts of the Agency, the greater portion of Rajputana is comprised of a complex of very ancient rocks, the most recent of which probably dates back to the period prior to the evolution of animal life on the globe—though recently, certain minute discoid markings found in the Vindhyans have been doubtfully attributed to forms of primitive brachiopods. Therefore, with the exception of the important period of Mesozoic volcanic activity, resulting in the Deccan trap basaltic lava flows, the period of rock formation in the Rajputana area had, in all probability, closed prior to the commencement of the Palæozoic. The pre-Palæozoic eras are, however, fully represented by formations (3) to (9) enumerated above, and of these formations the oldest—(9) Pre-Aravalli rocks—probably represents some of the most ancient strata exposed on the Earth's surface. During the enormous lapse of time that succeeded the genesis of animal life on the globe, Rajputana has in fact remained a portion of Gondwanaland, raised above the level of the sea and exposed to weathering and denudation except in the north-west where beds from the Jurassic to Eocene were deposited. As a result, its ancient mountain systems, running N. E.—S. W., have been gradually worn down so that, at the present day, only the "roots" remain, though comprising peaks of over 5000 feet in height.

One of the principal results of this careful and detailed survey is the evidence of the vast period of time that these ancient (Archæan) formations must represent. In addition to the *æons* that must be allowed for the deposition of the many tens of thousands of feet of sediments that are included in many of these systems, within this geological sequence, three *major* erosion unconformities have been discovered. Occurring at the base of the Aravalli system, at the base of the Raialo series, and at the base of the Delhi system, these unconformities each represent a time-interval of sufficient duration to allow the pre-existing rocks to be folded (in some cases very intensely), subjected to igneous intrusion, metamorphosed, uplifted above sea-level and to be

eroded by sub-aerial agencies. Each of these periods of diastrophism was followed by one of subsidence and submergence during which the next group of sediments was laid down. Less important unconformities also occur within several of the systems.

In addition, granites and associated igneous rocks of at least four different ages have come to light. These periods of igneous activity include :—

1. Pre-Aravalli, the Bundelkhand gneiss, and probably several of distinct ages in the banded gneissic complex.
2. Post-Aravalli and pre-Delhi, an acid granite.
3. Post-Delhi, the Erinpura granite, which, with its pegmatites, extends throughout the synclinorium, including those of north-eastern Rajputana and Jaipur.
4. The Malani granites (Jalor and Siwana) are much younger than the Erinpura granite, and they and their associated rhyolites are quite distinct from it.

Basic and ultrabasic rocks the formations.

A new suite of basic and ultrabasic rocks, older than the Malani series but younger than the Erinpura granite, has been discovered by Dr. Coulson in Sirohi State. The youngest of all the igneous rocks is dolerite, excluding of course the Deccan trap.

A brief description of the various rock formations, which strike in a general N. E.—S. W. direction, is as follows :—

Pre-Aravallis

These include the Bundelkhand gneiss and the Banded Gneissic Complex, and represent the oldest rocks of the area. No definite conclusions can, however, be arrived at regarding the geological relationships of these two metamorphic and igneous groups, as their mutual junction is everywhere concealed by a broad syncline, composed of Aravalli rocks resting unconformably on both of them. The Bundelkhand gneiss is a true granite, unfoliated except in its extreme western extension. It is non-porphyritic and remarkably uniform in type ; it is traversed by intrusive dykes of dolerite and huge quartz reefs. On the other hand, the Banded Gneissic Complex was originally a sedimentary formation, mainly argillaceous, with arenaceous deposits (now converted to massive quartzites) below. At the present day it occurs as a complex of highly metamorphosed gneisses, into which are intruded numerous acid and basic igneous rock, varying considerably in age and texture.

Aravalli system

This system includes an immense thickness of less metamorphosed sediments, particularly shales and phyllites, with some impure limestones and fine-grained quartzites. Its base is marked by a thin grit-bed. In two areas, volcanic lavas and tuffs occur near the base of the sequence. In certain areas, as a result of *lit-par-lit* injection by acid granite magma, gneisses have been produced, but, on the whole, igneous intrusions other than white quartz veins are less common than in the pre-Aravalli and Delhi rocks. In south-eastern Mewar, where the Aravallis have undergone practically no metamorphism, they consist of shales, not greatly disturbed. As they are traced across the strike from east to west, in the direction of the ancient belt of mountain-folding and ignec intrusion of the synclinorium, dips steepen, and they become successively slates, phyllites, and ultimately mica-schists, whilst the intruded dolerites epidiorite and hornblendeschist. The suggestion is made that the Gwalior rocks of Central India are also unaltered Aravallis that have escaped metamorphism.

Raialo series

This series is the thinnest and simplest of the formations under discussion. It includes, in places, a thin, occasionally conglomeratic quartzite at the base, followed by about 2000 feet of white crystalline limestone, capping which, near Kankroli, are garnetiferous biotiteschists. These crystalline limestones include the celebrated 'Makrana marble' of Jodhpur State and the 'Bhagwanpura limestone' of the Mewar area. The limestone is very free from igneous intrusions, only a few dykes of post-Delhi pegmatite occurring within it.

Delhi system

The rocks of this system are exposed in an immense synclinorium that extends throughout Rajputana from north-east to south-west, disappearing from view beneath the Indo-Gangetic alluvium at the north-eastern end near Delhi and under the alluvial deposits of the Gujarat plain at the south-western extremity. In the main synclinorium, the Delhi system has been subdivided as follows:—

Ajabgarh series	5. Biotitic limestones - 'calc-gneisses' and calciphyres.
	4. Calcareous shales and impure limestones — 'calc-schists'.
	3. Phyllites and biotite-schists.
Alwar series	2. Quartzites.
	1. Arkose grits and conglomerates.

The Alwar series is irregularly developed. In the northern part of the synclinorium both the quartzites and the basement grits are well represented, the latter in places becoming coarse conglomerates. The beds include much felspar derived from the erosion of the older granites and pegmatites that formed the existing land-surface during that period. The Alwar series dies out in the medial portion of the syncline, but thickens again to the south.

The Ajabgarh series includes a basal schistose stage into which numerous pegmatite and aplite dykes have been injected, causing degrees of metamorphism from phyllite through biotite-schist to composite gneiss. The overlying 'calc-schists' where least metamorphosed—as in the extreme south—occur as calcareous shales and impure limestones (the Mundeti series of Middlemiss). In other areas, this series is represented by highly metamorphosed, though stratified, rocks, intruded by large sills and dykes of pegmatite. The 'calc-gneisses', relatively unaffected by metamorphism in the north-eastern part of the synclinorium, include dark, banded biotitic and siliceous limestones, which pass gradually into true 'calc-gneisses' to the south-west, where metamorphism has been more intense. The present banding of both the 'calc-schists' and the 'calc-gneisses' is essentially the same as the original stratification, the original rocks consisting of alternating layers of calcareous sediments and argillaceous and ferruginous sediments.

Erinpura granite

The earliest intrusives into the strata of the Delhi system were basic rocks now metamorphosed to epidiorites; ultra-basic igneous rocks of younger date also occur. The principal post-Delhi intrusive is, however, the Erinpura granite, occurring as masses of various dimensions and showing wide ranges of texture and degree of foliation. The types include veins and foliated sheets followed by granite batholiths of larger sizes, often unfoliated. This phase of granite intrusion culminated with the injection of innumerable pegmatites.

Malani volcanics and Jalor-Siwana granites

The Jalor and Siwana granites, with their attendant hypabyssal and volcanic representatives—granophyres, porphyries, and rhyolites—form the Malani series, and are well developed to the west of the Aravalli range. They are the youngest igneous rocks of this Archaean suite, with the exception of certain dolerite intrusives which intersect the Delhis, the Malani series, and also the Lower Vindhyans, in the last case not in Rajputana but in Mirzapur district, U. P.

For a description of the Vindhyans, reference should be made to the various papers by Dr. Heron and his colleagues, published by the Geological Survey of India.*

—*E. R. Gee*

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* Published with the permission of the Director, Geological Survey of India.

On Storage and Use of Radium in Radio-therapy

D. M. Bose

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In connection with the recent Centenary Celebrations of the Medical College of Bengal, it has been proposed that a part of the funds raised should be spent in buying a quantity of radium for use in radio-therapy. I would like to draw the attention of the authorities concerned to one particular point in connection with the radium containers, to which sufficient consideration has not been given in this country.

As is well-known radium is an unstable element which breaks down and gives rise to a gas called emanation or (radon), which in turn gives rise to various disintegration products, of which the most important from the medical standpoint is RaC. This is a source of penetrating γ-radiation with which malignant tumours are irradiated and which alone is, therefore, of medical value. A tube of radium compound contains all its disintegration products including RaC in equilibrium, and can, therefore, be used for radiological purposes. In this country the practice is to seal up the available supply of the radium salt in either a single tube or a number of them, and to use one or more of them for the treatment of patients. The drawback of this arrangement is: (*i*) these radium tubes are very small in size, and, being made of glass, are liable to breakage or to be misplaced, (*ii*) the treatment can only be given at the central station which possesses this supply of radium. An alternative method which is used with success in many important centres of radium therapy like Paris, Vienna etc., and also research centres like Cambridge, is to keep the whole quantity of radium salt in solution in a container which is adequately secured in a safe arrangement built in a portion of the building, from which the radioactive emanation is drawn off by means of a mercury pump, and the latter after purification can be sealed in glass ampoules, and these after a short period become active source of γ-rays. These ampoules or radon tubes can be used for treatment in the hospital, or can be given to physicians for their private practice and can be sent to different distant stations. Thus while the parent solution is kept in security in the central hospital, the range of applicability of radium therapy is very much widened by this method of using emanation filled tubes. For example, the National Medical Hospital of Dublin possesses 350 mgs of radium, and 11000 radon tubes were lent to different parties in course of a year.

To physicists interested in studying the problems of nuclear disintegration this latter method of using radon tubes has great advantages. It is found that Polonium (which gives out α-rays only) when mixed with berryllium is a powerful source of *neutron* and also of penetrating γ-radiations. In many investigations it is necessary to use a radioactive source which emits α-particles only. It is found that the end product of the disintegration of radon is Polonium, and it is the usual practice in western countries to recover this Polonium from used up radon tubes. In many investigations, physicists have also used radon tubes of great intensity for the study of nuclear transformations. It is wellknown that Prof. Fermi and his collaborators in their brilliant researches on the induction of artificial radioactivity by bombardment with neutrons have used radon tubes containing emanation from 800 mgs. of radium. Scarcely any scientist, except some perhaps in America, and Prof. Piccard at Brussels who keeps for the Belgian government all their radium mined from the Congo Free States has at his disposal sufficient funds to secure that quantity of radium, and unless radon tubes were available from hospitals, where large stores of radium are kept, research work in these lines could not have been undertaken in many centres even in Europe.

No one can hope to carry on investigations on similar lines in this country, unless he can have at his disposal adequate supply of radioactive material. It will be remembered that in the first issue of *Science*

and Culture, Mr. H. P. De published a beautiful photograph of the conversion of γ-rays into a pair of electrons. Mr. De who is working in my laboratory, has at his disposal only about 5 mgs. of radium bromide and 10 mgs. of mesothorium. Many interesting investigations which could be undertaken here are held up for want of adequate supply of radioactive material. In all progressive countries of the west there is active co-operation between medical radiologists and nuclear physicists *e. g.*, many important investigations on artificial radioactivity are being done by McLennan, Szillard, and others in the radiological laboratories attached to different London hospitals. In India, the Patna Medical College possesses the largest quantity of radium *viz.* 1600 milligrams, and this quantity is kept in small tubes. The radium would have been of much greater use to physicists as well as medical practitioners if it were stored up in a safe, and arrangements were made to prepare radon tubes. We earnestly hope that the authorities in charge of the Centenary Celebrations when purchasing their supply of radium salt will give due consideration to the question of storing the same in the form suggested here and also to explore the possibility of making the supply, available to physicists and others interested in the problems of nuclear physics and chemistry in this country.

As has been mentioned before, the collection of radium emanation in separate ampoules from the radium salt solution in the containers, is done simply with the help of a mercury pump, and requires no elaborate technic; it can be easily worked out by any physicist with a little training in glassblowing. The cost of maintaining an establishment for the collection of radium emanation will be very small and may be raised from outside people if the radon tubes are lent out on hire system, or sold as is done elsewhere. In fact, at Cambridge (Cavendish Laboratory), at Paris (Madame Curie's Laboratory), and at Berlin (Prof. Lise Meitner's Laboratory), the preparation of radon tubes is entrusted to an experienced laboratory boy, trained for the purpose.

Calcutta Filter-works and Organic growth

K. Biswas

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Controversies in what appears to be an insoluble problem are going on between the custodians of the Calcutta Corporation responsible for the supply of drinking water and the citizens of Calcutta rightly demanding for healthy water free from bacteria, undesirable organisms, or unpleasant odour and taste. Discussions on this vital question from various aspects find expressions in the columns of the local newspapers almost daily. It is presumed that filter-water of Calcutta is mainly the cause of prevalence of virulent diseases in the town. Sporadic examination sometimes leads to the discovery of germs of deadly diseases. Such a finding offers sufficient ground in making Calcutta Corporation a target of volleys of questions from the public regarding access of such bacteria to the water pipes. Explanation not without reason has been offered in what is generally called contamination in underground pipe system, The engineers of the Calcutta Corporation get puzzled at the discovery of bacteria in the pipes and make futile endeavours to solve the question from evidently purely engineering standpoint. The never-ending controversy, as usual, leads to the formation of committees, and we are all awaiting the results of the committees which will perhaps declare, if I am permitted to speculate, that both the public and the Corporation are justified in thinking in their own way. Accidental presence of bacteria in water is not the only criterion for judging purity of water. In spite of considerable need and scope for improving

Calcutta water, I am of opinion that it is not unhealthy.

The writer happened to investigate the filter-beds of Calcutta and other cities in India. He has discussed in two previous reports and in his other scientific papers the biological aspects of the problem. By 'biological aspect', I mean the relation of zooalgal growth in the filtering process of our drinking water. This is of vital importance, and any suggestion for the betterment of drinking water means improving the biological conditions of the filter-beds and underground pipes. Sporadic findings of bacteria in the town supplies forebode sufficient danger but the remedy does not lie in simply taking preventive action against contamination in conduit pipes, but it lies in the detailed biological investigation of the whole process of filtration. Such an investigation aided by efficient engineering advice and service might throw some light in controlling bacterial or other organic growth in conduit pipes or access of pathogenic bacteria by contamination. Sufficient velocity in the mains under high pressure reduces chances of underground contamination in pipes. But if the biological conditions of settling tanks, filter-beds, and storage water are not what is desirable, development of bacteria and their final access to the tap water is not a farfetched conclusion. Investigation should, therefore, be made to trace if the presence of bacteria is—first due to contamination in under-ground pipe system, secondly due to the organic growth such as Iron bacteria, fungi, algae in under-ground pipes offering suitable medium for the growth of bacteria in cases of accidental contamination, and lastly due to the general chemical, physical and algological conditions in the filter-beds during the process of filtration.

There are various processes of filtration, but I shall deal here very briefly with the process of filtration adopted in the Calcutta Water Works at Phalta. The filtering arrangements in this second city of the Empire are one of the best of its kind in the east.

The raw water pumped from the river first passes over blocks of alum suspended from cranes, and then flows into settling tanks for deposition of silt. The water then gradually passes on to a large tank known as the New Storage Tank. From this tank the water finally flows into the filter-beds for filtration. The filtered water is now collected in a collecting well from which it is pumped into the mains for the supply in the city. This is the open filter arrangement, and naturally apart from its many advantages and beneficial effects on the purity of water it is associated also with all its evils in the tropics. Conditions of filtration become complicated due particularly to its present situation at Phalta and to the climatic conditions of Calcutta. The trouble is inevitable and starts from the ground layer of organisms. This layer is known as "Schmutzdecke" by the German investigators, or the "vital layer". This slimy layer is formed of bacteria, minute blue-green algae or fungal bodies and particles of clay strained out of water in close proximity to the surface of the sand. The accumulation of undesirable organisms in this spreading mat tends to clog the filter resulting in a rapid loss of head. It also produces conditions conducive to the growth of algae which flourish luxuriantly in the water of the filter-beds already surcharged with dissolved salts as it overflows from the settling tanks into the filter beds. Algal and fungal spores settling on the suitable substratum of "Schmitzdecke" rapidly develop. Plankton algae are predominant in some of the beds in their early stages. But when these ephimerals disappear filamentous members chiefly *Tribonema bombycinum Cladophora crispata, Hydrodictyon reticulatum* gain the upper hand. At first these larger algae grow on the bottom layer of the filter-beds, but soon due to gases caught up in their interstices they are lifted up, and finally float on the surface of the water as dense mass of vegetation. Such vegetable growth leads to the development of lower animal organisms. Such a mass of vegetation then sustains myriads of Protozoa, Rotifera, Crustacea, Bryozoa and Spongidae, by offering food and shelter. Thus encroaching upon the filter-beds the zoo-algal growth causes fissures in the vital layer, which affect the filtering operation and present considerable chances of becteria passing through the filter-beds and finally finding access to the taps, if perchance they remain alive during their sojourn. Such vegetable and animal growths are also responsible to the offensive vegetable odour caused by colloidal vegetable matter. This unpleasant vege-

table odour varies at different seasons. It may be mentioned here that alum treated water is more subject to organic growths. Such water, although it may be bacteriologically free either with or without chemical treatment, is not unsuitable for the development inside the conduit pipes of such organisms as Iron bacteria namely *Leptothrix ochracea*, *Cladothrix sp.*, *Galleonella sp.* and *Arcella sp.* These iron bacteria by their chemicosynthetic activities can live in darkness inside the underground iron pipes. Other organisms, as my examination of tap waters from different parts of the city in 1929 reveals, are Protococcus viridis, Chlorella vulgaris, Synedra affinis (Diatom). Recently the discovery of Carvospongilla lapidosa choking up the intake pipe of the Dacca municipal water works is to my opinion due mainly to the biological nature of the water passing through the pipe.

The biological condition of the water from the stage of raw river water as pumped into the settling tanks up to its final stage as it comes out of taps requires investigation. Sporadic biological examination alone is not likely to lead to any tangible result. No speedy remedy for the betterment of the water can be suggested. Continental investigators of water works also confirm my views to a large extent. For the control of undesirable organic growth of such a large water work as of this city, co-operation of a trained band of workers composed of biologists, (algologist, protozoologist, bacteriologist), chemists, physico-chemists and engineers is imperative. Such a band of workers will investigate the daily conditions of water as it is pumped into the settling tanks, to the filter-beds, to the overhead and underground storage reservoirs, then to the mains and branch conduit pipes, and finally to the taps at different parts of the city. If during their examination anything doubtful is found out, immediate steps for its remedy may be suggested. Contamination in the pipes, or putrefaction in the settling tanks, filter-beds or storage reservoirs can then be easily detected. Such a board of team workers more or less control nearly all the large water works in the European and American continents. In England there is a board of water purification under the title of Water Pollution Research Board (London). This board along with its other activities, publishes monthly resumé of a large number of papers embodying valuable results of various investigators of the water-works throughout the world. In consideration of the safety of such a huge population of this premier city, where the supply of even about 55 million gallons of water is considered insufficient, it is essential that a board of team workers should be formed to take up the investigation as early as possible, for the benefit of the ratepayers. Criticisms, speculations, meetings, and stray examinations are but temporary measures which, the author of this note believes, will have very little lasting effect upon improving the quality of water supplied.

Obituary

Prof. Ganesh Prasad: His Life & Work.

Professor Ganesh Prasad, who died at Agra on the 9th March, 1935, was the pioneer of modern mathematical researches in India, and was generally recognized to be the foremost Indian mathematician of his time. He had gone to Agra to attend a meeting of the Executive Council of the Agra University, and while the meeting was still going on, he resumed his seat after having made a short speech, and had a sudden attack of a violent type of cerebral hemorrhage. He expired within five hours in the Thomson Hospital, to which he had been removed. Thus after a very busy and active life, he died literally in harness.

Born at Ballia, a town in the eastern part of the United Provinces of Agra and Oudh, on November 15, 1876, Dr. Ganesh Prasad came from a middle class family, his father, Babu Ram Gopal Sinha, having been a *Kanungo* in the Government service. After passing in 1891 the Entrance Examination of the Calcutta University in the first division, he joined the Muir Central College, Allahabad, and graduated with First Class Honours in Mathematics in 1895, standing first in order of merit in the University. While in the B.A. classes, he was attending Honours courses both in mathematics and physics simultaneously, and was very keen to take the examination in both these subjects; but the university rules being against it, he finally decided to appear for mathematics only, an important factor in this selection being, as he told me later on the great admiration and devotion he always had for the late Professor Homersham Cox, his teacher of mathematics.

Having passed the M. A. Examination from the Universities of Calcutta and Allahabad, he made up his mind to take the D.Sc. degree which could, in those days, be secured on the result of a written examination, the supplication of a thesis not being compulsory, as at present. The University, although it had formally instituted the D. Sc. degree, had not laid down till then the necessary rules and regulations, and the application Dr. Ganesh Prasad made did not receive a quick response. But as a result of repeated reminders the University had to arrange for the examination rather abruptly and he got only about a month's time for preparations. But though no definite standard of the D.Sc. Examination was set up by the University authorities he resolutely went in for it, and came out successful in 1898, thus being the first D. Sc. of the Allahabad University.

It was really at this stage that the research career of Dr. Ganesh Prasad began. He wrote a short note on potentials, quoted by Routh in the second volume of his *Analytical Statics* (p. 126). Awarded by the Government of India a foreign scholarship, he proceeded for advanced studies to Cambridge, where he obtained the Mathematical Tripos. While at Cambridge, among others he came in contact specially with Prof. Hobson who alone of all the Cambridge mathematicians exercised a definite influence upon him, and, as a matter of fact, was instrumental in turning him to the line he chose for his mathematical activities. Like Hobson, though on a much smaller scale, he at first started with Applied Mathematics consisting chiefly of potential theory and spherical harmonics, but gradually turned to the theory of Functions of a Real Variable. From Cambridge Prasad went to Göttingen; there he worked under the late Prof. Felix Klein who communicated his long memoir entitled *'Constitution of Matter and Analytical theories of Heat,'* to the

Royal Society of Sciences of Göttingen. He also came in contact with Herr Hilbert who made enquiries about him when I happened to meet him at his place in 1930. In his talks, Prasad would enthusiastically refer to Klein and Hilbert, sometimes applying to the former the epithet of Prince of Mathematicians. After a sojourn of about four years in Europe, he came back to India with a high reputation as a mathematical scholar. This did not fail to attract the notice of the educational authorities in India, and he was appointed a temporary professor of mathematics at the Muir Central College, Allahabad. Soon he was made permanent and posted in the Queen's College, Benares, in the Provincial Educational Service. It may be mentioned in this connection that the fact that, at this time, another man with just an ordinary tripos qualification was given a higher post and that Dr. Prasad's claims were unjustly overlooked, caused bitterness in the minds of his friends and admirers.

These were the days when sea-voyages and sojourn in Europe were not sanctioned by society, which was mainly orthodox and went so far as to outcaste the unfortunate traveller who 'crossed the waters'. On his return to India, Dr. Prasad was accordingly received coldly by his castemen and threatened with social ostracism. To a sensitive man like him, this was enough to leave a permanent effect in his mind, and, in fact, many of his later-day idiosyncracies owe their origin to these events. On the one hand, there developed in him a very indifferent, almost defiant, attitude towards the high educational authorities, and on the other, he became almost a recluse, avoiding and shunning all societies and social functions. As a result he gained such a clock-like regularity in all he did that it was said of him that he reached the college so punctually that his arrival there would indicate that it was time for the bell to go.

In 1914 in the Calcutta University, the Ghosh Chair of Applied Mathematics was created, and Dr. Ganesh Prasad was appointed its first Professor. Here he found ample leisure, facilities and encouragement to devote himself heart and soul to the study of mathematics, and soon created an active school of mathematical research.

After the establishment of the Benares Hindu University in 1918, Pandit Madan Mohan Malaviya prevailed upon him to be its first Principal, and Professor of mathematics. He threw himself heart and soul into the affairs of the University: he was no longer a mere professor and a recluse, but became an active University politician. Inspite of the distractions due to the arduous duties of a principal and the busy life of a University politician, he found time, and had the energy, to continue his mathematical work in the nights.

Dr. Ganesh Prasad was intimately connected with the Calcutta Mathematical Society for a long time, and was at the time of his death its President. He established in 1918 the Mathematical Society at Benares, of which he was elected later on the Life-President. Here he had to guide a number of students in mathematical investigations, and had to work hard, what with his duties in the University and what with the directions he had to give to his scholars. We can, therefore, well imagine what a strenuous life he had at this time. The result was that it largely told on his health. After two years, therefore, he had to give up the office of the Honorary Principalship but continued there as Professor for another three years. On account of some differences with the University authorities he tendered his resignation from the Professorship in 1923, and went back to Calcutta as Hardinge Professor of Higher Mathematics. This is a chair for pure mathematics and had been occupied before him by A. R. Forsyth, W. H. Young and Cullis. He held this post till the day of his death.

Before passing on to the contribution of Dr. Ganesh Prasad in mathematics, it may be worth while to refer briefly to some aspects of his life. A most remarkable feature about him was his extraordinary memory. He would never forget the name and details of a person whom he might have met casually for a few minutes. Whilst he was the Principal of the Central Hindu College, he recognised all the students, numbering more than a thousand, and remembered not only their names but also many minute details about them which he might have had gathered by meeting them only once, at the time of their admission. He had an almost incredible capacity for doing hard work and his life was so plain and austere that in certain respects it might well be

regarded as that of an ascetic. I have seen him sleeping on a cot, knitted with iron wires, with newspaper sheets in place of a mattress and books serving as pillows; his diet too was extremely simple.

Though Dr. Ganesh Prasad lost his wife in early youth, he never married again inspite of the many solicitations and requests made by his relatives. The only issue of his marriage was a daughter who too died before she attained a marriageable age. He had thus no family of his own, but took much interest, at least in later years, in his nephew, niece, and step-brother.

Apart from scholarly pursuits, Ganesh Prasad had little interest in any other activity. Games and sports, entertainments and amusements, had no attraction for him. He was a voracious reader, which, coupled with his remarkable memory, made him a truly versatile scholar. He was a good scholar of Persian, spoke German fluently, and knew French and Italian. An early hobby of his was the study of history, and his recreation in later days was the reading of novels and short stories, particularly detective stories. He was a brilliant conversationalist, and his talk was full of subtle humour.

Perhaps the most remarkable feature about Ganesh Prasad was the attachment and personal bond that subsisted between him and his pupils. As was repeatedly remarked by various speakers in the meeting of the citizens of Allahabad, assembled to mourn his death, he always won affection and admiration of his pupils and wonderfully succeeded in creating enthusiasm for the subject he taught. Kind and helpful to his pupils, he was a source of great inspiration to them. There are cases in which some of his most brilliant pupils gave up their idea of trying for more lucrative professions, and, just for his inspiring personality, decided to adopt a mathematical career. I had been his pupil and, later on, his colleague on the staff of the Benares Hindu University, and he gave me the privilege of being one of those who were most intimately connected with him, and I may be allowed to say that there was something indescribable in him, which drew at once the affection and the entire confidence of his pupils in a manner such as no other teacher, so far as I am aware, had ever enjoyed before. He produced quite a large number of students, now spread throughout the length and breadth of northern India.

The extra mathematical activities of Ganesh Prasad consisted chiefly in University affairs, in which he always took a very active part. He was connected with almost all the Universities of northern India, and served on the Executive Council of a number of them. As could but be expected from a man of such varied experience and wide activity, he showed amazing knowledge of the work and procedure of the University affairs. In discussions, in which he seldom missed taking part, he was outspoken and straightforward, and showed great courage and independence of mind on many an occasion. He was a man of strong convictions, and whatever he thought right he would not shrink to fight for, or advocate, even in the face of formidable opposition. He represented the Allahabad University in the Provincial Legislative Council for three years, and was always a force to reckon with. He was a powerful supporter of the scheme of the Agra University, which came into existence in 1930.

Ganesh Prasad published a fairly large number of notes, papers and memoirs. His work can be roughly classified in three groups. The first group consists of papers on Applied Mathematics, generally potential theory, in which he skilfully employed his knowledge of the theory of functions of a real variable. The writers previous to him had not considered the cases in which, under special circumstances, the differential co-efficients either became infinite or did not exist. Such cases were carefully considered by Prasad. As an important contribution of this group may be mentioned his memoir entitled, "*Constitution of Matter and Analytical theories of Heat*", published by the Royal Society of Sciences of Göttingen (1903).

The second group consists of papers on the theory of a real variable proper, mainly on *Fourier Series*. This constituted the bulk of his work. He based most of his work on a special type of functions having discontinuities of the second kind. The function $f(t) = \varkappa(t) \cos \psi(t)$, in which $\varkappa(t)$ is limited or unlimited, but monotone, and $\psi(t)$ is monotone in the neighbourhood of origin and tends to infinity as t tends to zero, served throughout as his unfailing weapon which he skilfully employed almost every-

where. He wrote a long paper on the *functional nature of θ in the Mean Value Theorem of the differential calculus* (Bulletin Cal. Math. Soc. *20*, 1928)

The third group of his papers consists of those on spherical harmonics chiefly on Legendre's function and series. Here too, he employed his favourite function *f (t)*. He had planned a long memoir on the "*Expansion of Zero*" which he had promised to contribute to the newly constituted National Institute of Sciences, India, but death took him away before he could complete it.

Ganesh Prasad wrote two elementary text books *on Differential and Integral Calculus*, and a number of books on higher mathematics and on the lives of some mathematicians. Two volumes of his book, entitled "*Some great Mathematicians*," have already come out. At the time of his death he was busy in writing the third volume, in particular the chapter on Volterra, about whom he enquired several things from me a day previous to his death. The following is a list of the books on higher mathematics, published by Prasad :—

(1) Partial Differential Equations of Mathematical Physics.

(2) An Introduction to Elliptic Functions and Higher Transcendentals.

(3) Six Lectures on recent researches in the Theory of Fourier Series.

(4) Six Lectures on recent researches about the Mean Value Theorem.

(5) A Treatise on Spherical Harmonics and the Functions of Bessel and Lame', part I & II.

His book, "*Fundamental theorems of the Functions of a Complex Variable*," was passing through the press when he died. Of the above books, those on Fourier's Series and Spherical Harmonics seem to have been popular. His presidential address on "*Mathematical Research in the last twenty years*," delivered in 1920 before the Benares Mathematical Society, is a beautiful document of the most important advances in mathematical knowledge during that period ; this has been translated into German by Dr. F. Lange (Walter de Gruyter & Co., Berlin). Two of his other presidential addresses, *viz*: "*On the Functions and Needs of a Mathematical Society*", delivered before the Benares Math. Soc. in 1919, and the one delivered before the Calcutta Math. Soc. (*Commemoration Volume* 20, pp. 101-108) are highly interesting, the former being very informative and the latter, in which he discusses the question, "*why was the organization of mathematical research in India so inordinately delayed?*" quite thought-provoking.

B. N. Prasad.

Notes and News

The riparian tracts of the mighty rivers of India are sometimes subject to erosion on a very large scale. Many prosperous cities and centres of population in different parts of India have been washed away by rivers. The classic examples are furnished by the city of Hastinapur, the scene of the incidents recorded in the Mahabharata which, according to the testimonies of the Puranas, was washed away by the Ganges. A large part of the old Pataliputra was also washed away by the Ganges. It is also supposed that Uragpur, the old capital of the Pandya kings of South India, was washed away by the Kaveri. Probably no parts of India have suffered more from erosion than the riparian tracts of the Indus and the Ganges, particularly near about the lower Ganges. In this area whole cities and districts have been washed away by erosion of the main streams, carrying the water of the Ganges, the Bramhaputra, and their various branches. For the last several years two small country towns, Serajgunja and Noakhali, have been in constant danger of being washed away. As a result of persistent public agitation, some protective measures were undertaken, which have saved the town of Serajgunja. In Noakhali, the Municipality has undertaken some protective works, and from the latest press reports it appears that this town too is out of danger.

The methods generally used in these works as well as in other parts of India, do not appear to be very up to date. In America the river Mississippi is notorious for its eroding activities. The American engineers have found that the best remedy is to make the river rebuild its own banks. The method usually followed is to construct several parallel obstructions made of wicker work at right angles to the bank, the free ends being fixed to steamers in the midstream. Due to these obstructions, water slows down, and the earth loosened from the bank cannot be carried away far. It settles down there and reforms the bank. In this way the dangerous bends and loops which are generally subject to strong erosion by the river are straightened out. From the press report it appears that a similar method has been adopted in constructing a *bundh* at Noakhali. The *bundh* is built with bamboo mattress placed along the bank in three successive steps, and the intervening place is being filled with bricks. The process which was tried with success last year when the mosque was about to be eroded is expected to be very effective in arresting the surface erosion. It is noteworthy that there has been no progress of the erosion in those places where construction of the *bundh* has been completed. The total length of the *bundh* is 500 feet.

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The Report of the Secretary to the High Commissioner for India, London, Education Department, and the High Commissioner's observations thereon, have recently been published, and are both informative and interesting. The Report gives copious informations regarding the life and achievements of the Indian students in Great Britain. The record of academic successes of Indian students in British universities has been quite good. Among the degrees and distinctions secured are 2 Doctors of Science, 37 Doctors of Philosophy, 6 Memberships of the Royal College of Physicians, London, and 6 Fellowships of the Royal College of Surgeons. At Cambridge Mr. Adarkar won the Adam Smith Prize, and Mr. Pendse the Rayleigh Prize. The general standard of the students coming from India also shows an improvement. Of the 610 candidates who applied for admission through this department, about 75 per cent. were graduates, and the majority of the remainder had at least passed the Intermediate Examination. The number of women students is steadily increasing. In the year under review there were about 70 students in British universities and colleges, the majority of whom studied medicine and education. As regards the arrangement for practical training in factories and workshops, it appears that there has been no reluctance on the part of the industrial firms to grant facilities except in cases where secret processes, severe trade competitions, or trade union regulations, were involved.

The Report raises some important questions to which all young men proposing to go to Great Britain as students in near future, and specially their parents and guardians, must pay careful attention. The first question relates to the kind of students who ought to go abroad for training. About 2,000 students remain in foreign countries every year, and it is more than possible that for many of them it is a mere waste of time and money. It is, therefore, desirable that there should grow a sound and strong public opinion in this country that the young Indian student can best serve his interests by staying in his own country, unless and until there is a real need for him to go abroad for further study or training, or for intellectual stimulus. Next comes the question of financial responsibility. The High Commissioner says in this connection, "There does not seem to be sufficient appreciation by parents and guardians in India of the suffering and hardship inflicted on students who are sent out to foreign countries without adequate financial provision for their maintenance." During the year covered by the report, no less than twenty three students had to be repatriated by the High Commissioner while fifty three received financial assistance from the Indian Students Loan Fund Committee. The number of students who needed help but did not seek it from the office, must have been much larger. Finally comes the most serious problem of all, the problem of unemployment. "Each year a large number of Indian students, equipped with excellent, and in many cases exceptional qualifications, return home. For the restricted openings in the Government service or in private enterprise, they have to compete with the enormous number of students who have stayed at home and have graduated in all Faculties at the Indian Universities." But, then, this is only a part of a far greater problem.

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The annual report of the Patent Office shows that the number of inventions in India has steadily increased, and that, of 1,007 applications filed, 341 originated in this country, 129 being to the credit of Bengal.

The current year shows a marked increase in the number of applications for patents relating to electrical industries. Compared to the previous year, the increase has been over 70 per cent. The largest number of inventions is in the field of electricity, of which incandescent lamps and discharge tubes claim the highest number of applications.

The number of agricultural inventions is slightly larger than that of the last year. Indian inventors directed their attention mostly to the construction of small implements by the modern method of welding so as to avoid the loss of material occasioned in the older processes of drop-stamping and forging. They were also engaged in inventing portable sowing devices which enable seeds to be sewn in rows at a suitable distance apart. Most of the inventors of water-raising appliances for agricultural purposes belong to the Punjab, and their object was generally to improve on the gear arrangements for Persian wheels driven by manual or animal power.

Although the number of tea inventions sought to be protected in 1934 was slightly lower than in the previous year, it is interesting to note that half this number originated in India, the activities in this field being largely confined to the invention of various processes the green tea leaf undergoes before it turns black and crisp. Refrigerating machines also claim an increase in inventions. A large number of applications related to improved designs of domestic refrigerators, in which refrigeration is caused by intermittent absorption and expulsion of a refrigerating substance by an absorbent. The object of these inventions was to cause a relatively more efficient cycle of absorption and expulsion. Some inventors were concerned with improvements in methods of preparing and storing liquid and solid carbon dioxide. An inventor was engaged in the manufacture of solid carbon dioxide, speed of production and density being the desired objectives. The inventor stated that the increase in the density of solid carbon dioxide, obtained by increasing the pressure of the liquefied gas inside the container, is accompanied by a corresponding increase in the time for solidification. He accordingly devised a method whereby this difficulty can be avoided, and very dense 'dry ice' (as solid carbon dioxide is popularly called) obtained in a comparatively short time.

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In any scheme of education that imparted to girls

must necessarily form an important part. We so often find in India cultural and social discord between the two sexes, but this can be to a very great extent lessened, if girls are educated, for, an educated mother is the best guarantee of the education of her children.

Again, there is no doubt that the progress of education of a nation depends largely on an adequate supply of lady teachers. Women are, by general consent, the best teachers for children. In India, however, it is very unfortunate that their number is too small, the figure being that only about one in four of even the girls' primary schools has a woman teacher. The total number of lady teachers was only 6,469 in 1931-32, of which 1,269 were trained hands.

It is, however, refreshing to note that the education of girls has been of late engaging greater and more careful attention both from the public and the authorities concerned. It is also very hopeful to find that guardians and parents are more and more realizing the advisability of educating their girls as well as their boys with the result that today we find a definite increase in the number of educational institutions of women, and also of the students reading in these. A decade ago, there were only about 250 women studying for higher degrees in Bengal, and today this number has gone up to 1,000. As against 1,000 at high schools in 1922, there were more than 4,000 in 1933. Corresponding figures for secondary and primary stages reveal proportionate increases.

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Though the above figures all relate to Bengal, in all other forward provinces, there has been a similar progress in the education of girls. All this is very encouraging, and bids fare to entertaining high hopes about the future education in this country. But our educational authorities must not rest here. That there has been already some progress is just the reason that it must go on. There is, however, a great need for systematic co-ordination and control so that the growth may not be haphazard and may yield the maximum possible results. It is to be hoped that female education in this country will progress, with greater public co-operation, based on an understanding of the importance of education for women, more rapidly and on better lines than it has hitherto done.

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For sometime past the Calcutta University authorities have been contemplating a revision of the Matriculation Examination regulations. They now want to abolish the restriction of age, make vernacular the medium of instruction and examination for all subjects except English, and to provide a training in technical and vocational subjects, which is so urgently called for in view of the growing unemployment among the University graduates. They, therefore, after a great deal of deliberations, submitted to the Government for sanction the report containing these recommendations. As a result of a good deal of correspondence and a number of conferences held subsequently, a large measure of agreement was reached between the University and the Government. Finally in Dec. 1931, the Calcutta University Senate appointed a committee to go through the whole scheme again in the light of these discussions. The revised regulations with detailed syllabuses were submitted to the Government for their final approval in Sept. 1932.

The final scheme was considered in August, 1934, by the representatives of the Government of Bengal and Assam, and of the Calcutta University. The revised regulations emerging out of their deliberations have been accepted in the main both by the University and the Government. According to this revised scheme, history and geography shall henceforth cease to be optional, and become compulsory, elementary science shall form a part of the regular syllabus, and vernacular shall be the medium of instruction and examination of all subjects, except English. The teaching of English will not suffer on this account, for necessary safeguards have been made to maintain the standard of the subject. The date from which the new scheme will come into effect will be settled by the University in consultation with the Government as early as possible.

The Budget Estimates of the Calcutta University for the current academic year, show that though its income is Rs. 24,54,767 the expenditure is Rs. 27, 24, 890, so that there is a deficit of Rs. 2,70,123 which will, therefore, have to be met from the opening balance of Rs. 3,38,752. In presenting the

Budget Estimates at a special meeting of the Senate on June 29, 1935, Mr. Rama Prasad Mookerjee, the President of the Board of Accounts, explained that this deficit was due to a reduced Government grant. The existing financial arrangements of the University with the Government lay down that whenever the University's Fee Fund exceeded Rs. 11,72,000 the Govt. grant of Rs. 3,60,000 would be reduced by half the surplus of the income over that figure. The deficit referred to above is due to a reduction in the Government grant on account of an increase of the University's Fee Fund. Mr. Rama Prasad Mookerjee deprecated the attitude of the Government in the matter. But he hoped and trusted that the question of the review of the whole position would be taken up and solved before the end of the current year, and that the University finances would be made more stable and satisfactory. Mr. Syama Prasad Mookerjee in endorsing the suggestion for the modification of the existing arrangement said that they wanted to proceed from progress to progress, but were held up for want of money. He, however, hoped that a satisfactory solution would be arrived at.

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G. M.

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The American workers, chiefly, S. J. and L. J. H. Barnet have investigated both the direct and the inverse effect for ferro-magnetic metals and alloys, and have noticed remarkable agreement between the results obtained in the two types of experiments, the mean value of R for all materials examined being of the order of 1·05 m/e, with a probable error not exceeding 1-2%.

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(Sanne *Zeit. fur. Physic 91*,521,1935.)

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Taxila.

University and Academy News

The National Institute of Sciences of India

Endowments

The National Institute of Sciences has received the following endowments :—

Central Provinces Manganese-ore Co., Ltd	Rs. 10,000
The Burmah Oil Company	Rs. 15,000
Dr. S. C. Law	Rs. 2,000
Dr. D. N. Wadia	Rs. 1,000 (in memory of Mrs. Wadia)
Calcutta University	Rs. 500 (per annum for two years).

Sectional Committees

The following Sectional Committees have been formed :—

(1) *Mathematics Committee :*

Prof. A. C. Banerjee, Mr. T. P. Bhaskara Shastri, Brigadier H. J. Couchman, Prof. C. V. Hanumantha Rao, Principal G. S. Mahajani, and Prof. N. R. Sen (Secretary & Convenor).

(2) *Physics Committee :*

Dr. Nazir Ahmed, Dr. P. N. Ghosh, Dr. C. W. B. Normand, Sir C. V. Raman, Prof. M. N. Saha, and Prof. S. K. Mitra (Secretary & Convenor).

(3) *Chemistry Committee :*

Prof. S. S. Bhatnagar, Prof. N. R. Dhar, Sir M. O. Forster, Prof. H. K. Sen, Mr. B. C. Burt, and Prof. P. C. Mitter (Secretary & Convenor).

(4) *Engineering Committee :*

Mr. A. C. Ash, Mr. H. P. Philpott, Principal F. Mowdawala, Dr. D. Penman, Mr. E. A. Wraight, and Dr. E. Spencer (Secretary & Cenvenor).

(5) *Geology Committee :*

Sir L. L. Fermor, Dr. G. S. Fox, Prof. K. K. Mathur, Mr. E. S. Pinfold, Mr. B. Rama Rao, and Dr. A. M. Heron (Secretary & Convenor).

(6) *Botany Committee :*

Prof. S. L. Ajrekar, Mr. H. G. Champion, Prof. M. O. P. Iyengar, Prof. P. K. Parija, Dr. F. J. F. Shaw, and Mr. C. C. Calder (Secretary & Convenor).

(7) *Zoology Committee :*

Dr. C. F. C. Beeson, Dr. F. H. Gravely, Principal M. Afzal Hussain, Dr. J. H. Hutton, Dr. K. N. Bahl, and Dr. B. Prashad (Secretary & Convenor).

(8) *Physiology Committee :*

Lt. Col. O. A. R. Berkeley Hill, Sir U. N. Brahmachari, Lt. Col. R. N. Chopra, Prof. P. K. Koshy, Lt. Col. R. Row, Lt. Col. A. D. Stewart, Lt. Col. J. Taylor, Mr. F. Ware, and Lt. Col. R. Knowles (Secretary & Convenor).

Magnetic Observatory at Cape Comorin

The following resolution (No. 21 n) passed at the meeting of the International Union of Geodesy and Geophysics in Lisbon in 1933 has been brought to the notice of the National Institute of Sciences of India :—

"The Association is strongly of opinion that there is an urgent necessity to establish a Magnetic Observatory in India at Cape Comorin or its neighbourhood and wish to express the hope that the Government of Travancore will contribute to the possibility of realizing this project. The Magnetic Observatory which was maintained at Trivandrum by the efforts of the late Mr. J. A. Broun has done much excellent work in establishing the fundamental conditions regarding the science of terrestrial magnetism ; in particular its situation has always been regarded as important owing to its

proximity to the magnetic equator. The Association is of opinion that restarting the Observatory in the neighbourhood of Cape Comorin will produce new results of great importance to Science". (Free translation from the original French).

In view of the very important magnetic observations taken by the late Mr. J. A. Broun, F. R. S. at the Magnetic Observatory at Trivandrum which he founded, and of which he was the Director from 1851 to 1865, and the fact Cape Comorin is very near the magnetic equator, and will therefore yield results of very great scientific importance in the science of terrestrial magnetism, the National Institute of Sciences of India heartily endorses the above resolution and prays His Highness the Maharaja of Travancore, whose predecessors have hitherto helped many important scientific enquiries, to consider sympathetically the question of the establishment of a Magnetic Observatory near Cape Comorin.

Symposium

At the next General Meeting of the National Institute of Sciences of India to be held on 23rd and 24th August, 1935, at 1, Park Street, Calcutta, there will be a symposium on 'Problems of the Ionosphere'. The discussion has been organized as follows :—

(1) Symposium to be opened by Prof. S. K. Mitra,

(2) Spectroscopic problems connected with the Ionosphere, Prof. M. N. Saha.

(3) Ionosphere and Thunderstorms and Magnetic Storms, Dr. S. K. Banerji.

(4) Measurement of the Ionosphere at Allahabad, Mr. G. R. Toshniwal.

(5) The D-layer, Mr. P. Syam.

Mr. P. J. Edmunds, Director of Wireless, is expected to attend the symposium.

Calcutta University

Special Reader

The Senate has appointed Dr. C. E. Turner, Mass. Institute of Technology, as Special Reader of the University to deliver six lectures on subjects relating to the Organization of Health Education. The lectures will be delivered in the next winter.

New features

The Calcutta University has introduced the following new features into its activities, and provisions are being made for carrying out the proposals in the next Budget :—

(1) Provision for a Teachers' Training Department.

(2) Arrangements for instructions in different Asiatic languages, including Chinese and Tibetan.

(3) Better arrangements for looking after the health of the students.

Letters to the Editor

Adsorption by Active Charcoal

Sugar charcoal, on account of its purity, has a great deal of theoretical importance from the point of view of adsorption on other charcoals, obtained from different sources. Miller[1] first worked with ash-free sugar charcoal and attributed the difference in the observations of Michaelis and Rona[2] and others with blood charcoal to the inorganic constituents of the ash present, incompletely decomposed organic matters and unsuspected acids adsorbed in their samples. It is a well-known fact that activation of charcoal, which consists in heating the charcoal at very low pressures for a long time, increases its adsorption capacity enormously. Schilow[3] attributes the activation of charcoal to the formation of two basic oxides *A* and *B* and one acidic oxide *C* on the charcoal surface, depending on the temperature of activation. Frumkin[4] considers charcoal as an oxygen or hydrogen electrode in presence of the respective gases—a property analogous to the wellknown behaviour of platinum. There would thus exist the usual relation between the pressure of oxygen and hydrogen and the acid and alkali adsorption respectively. Ockrent, however, ascribes it to the high temperature adsorbed water layer on the charcoal surface.

Raychoudhuri, Raychoudhuri, and Mukherjee[5], in a number of important papers, have contributed a good deal to the advancement of knowledge in this line. In one of the papers they have shown that the positively charged charcoal becomes negative at very low concentrations of hydrochloric acid solution and at higher concentrations of hydrochloric acid the charge again becomes positive. This peculiar variation of electrical charge connot be explained either by the theory of Schilow or of Frumkin.

Raychoudhuri and Mukherjee hold that the negative charge of the sugar charcoal decreases on continued washing before activation to a minimum, which on activation and repeated washings acquires a zero charge, and finally the charge becomes positive. Moreover they have shown contrary to Miller (who holds that activated sugar charcoal adsorbs acid but not alkali) that sugar charcoal activated at 600°C for 8 hours can adsorb both acid and alkali. Further that the maximum temperature for activation is 600°C and that either increase in the temperature of activation for a short time or prolonging the time of activation at a lower temperature would enhance the activity of the charcoal.

Recently Mukherjee, Acharya and Ray have obtained very important results (not yet published) with activated sugar charcoal. They have observed that :—

(a) The adsorption of organic acids such as benzoic, succinic, salicylic, malic, phthalic, picric, tartaric, sulphanilic, cinnamic and hydrochloric, is more markedly increased in presence of neutral salts than in their absence. The adsorbability of the acids is of the following order :—

Salicylic $>$ Benzoic $>$ Succinic $>$ Malic $>$ Phthalic Picric $>$ Tartaric $>$ Sulphanilic $>$ Hydrochloric $>$ Cinnamic.

(b) If the charcoal is coated with a thin layer of insoluble organic acids such as lauric, myristic, palmitic, stearic (from their alcoholic solutions), acid is liberated markedly by neutral chlorides (KCl, $NaCl$, $LiCl$, $RbCl$, $BaCl_2$, $SrCl_2$) while no appreciable acid is liberated from a similar experiment with water alone. Further on washing the charcoal (coated with acid) till the pH of the wash liquid is about 6 and then on its treatment with the neutral chlorides, the acid liberated is greater than that before washing. It is still more interesting to find that the charcoal, on being coated with insoluble acid acquires a high negative charge. (2.5 - 12.7), which again diminishes to about zero (-0. 4) in KCl ($N/1000$) solution. The last observation is in agreement with Mukherjee's theory of double layer.[6] It follows from the above theory that (since the charcoal is negatively charged) $H^{\cdot}$ ions must be present in the neighbourhood of the surface of the charcoal by electrostatic attraction either as bound ions or as free ions in the mobile sheet of the double layer. Thus these hydrogen ions are easily replaceable by other cations.

(c) The charcoal (charge-zero) being similarly treated with organic bases such as α-naphthylamine and diphenylamine liberates alkali with neutral chlorides.

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8-6-35.

H. K. Acharya.

1 *J. Phys. Chem.*, *30*, 1031, 1926

2 *Biochem. Z.*, *97*, 87, 1918

3 *Z. phys. Chem.*, *133*, 188, 1928 ; ibid, *136*, 34, 1928 ; ibid, *143*, 41, 1929

4 *Koll. Z.*, *51*, 123, 1930

5 *J. Ind. Chem. Soc.*, *8*, 433, 1931 ; *Koll, Z.*, *57*, 302, 1931 ; *Z. phys. Chem.*, *157*, 435, 1931 ; *J. Ind. Chem, Soc.*, *P. C. Ray Commemoration Vol.*, p, 209, 1933

6 *Trans. Far. Soc.*, *16*, 103, 1921 ; *Phil. Mag.*, *44*, 321, 1922 ; *J. Ind. Chem. Soc.*, *2*, 219, 1925.

The Existence of the Free Magnetic Poles

Sometime ago, Prof. Dirac[1] deduced the existence of free magnetic poles having the quantum of magnetic charge $e/2a$ on the basis of rather complex wave-mechanical treatment (e = charge on the electron, a = Sommerfeld fine-structure constant). The charge is therefore nearly 68 times as large as the elementary electrical charge. Dirac and Tomm tried to find out the eigen-values of such a magnetic charge moving in a central *e.s.* field, but obtained no results which could be satisfactorily interpreted in terms of any known physical phenomenon.

The object of the present communication is to show that the existence of such particle can be deduced from much simpler considerations. Let us have a magnetic pole m at a point A, and an electrical charge e at B. Then it can be shown from classical electrodynamics that the ***angular momentum*** of the system round the line AB is em/c when e is expressed in *e.s.* units, and m in magnetic units. We can put this equal to $\frac{1}{2}.h/2\pi$ according to the usual quantum conception. We thus obtain

$$\frac{em}{c} = \frac{h}{4\pi}$$

$$\text{or} \qquad m = \frac{ch}{4\pi e} = \frac{e}{2.2\pi e^2/ch} = \frac{e}{2a},$$

which is exactly Dirac's value.

Dirac expresses the opinion that the free magnetic pole, even if it exists, would have such strong attraction for the negative counterpart that in nature they would always occur in pair. Dr. D. S. Kothari expressed the opinion that the neutron is identical with this hypothetical magnetic doublet, for the nitrogen nucleus of 14 is found, from fine structure evidence brought forward by Bacher, to possess the magnetic moment zero, and the mechanical moment 1. As the nitrogen nucleus consists of particles (which possess neither mechanical nor magnetic moment), one proton and one neutron, we have to assume that the neutron possesses the mechanical moment of $\frac{1}{2}$ units, but its magnetic moment is equal and opposite of the proton. In other words with the proton, it forms an astatic pair within the N nucleus. Thus the neutron is seen to possess a magnetic moment of the order of $eh/4\pi Mc$. This is also supported by direct measurements of Stern and Eastermann of the magnetic moment of the Deuton.

If the neutron is really a magnetic doublet, a simple calculation shows that the length of the doublet is e^2/Mc^2 *i. e.* of the order of 10^{-17}cm. This is quite a reasonable value.

It may further be added that Dirac and Tomm used Schroedinger's wave equations for an electro-magnetic field for finding out eigen-values of the magnetic particle. This equation makes use of the existence of a vector potential defining the *e.m.* field. But the existence of the vector-potential depends, as is well-known, on the theorem that the density of the magnetic charges is zero everywhere throughout space. But though this hypothesis was quite in keeping with the older conceptions, the hypothesis of the existence of free particle renders it entirely invalid. Thus the equations utilized by Dirac and Tomm for calculating the eigen-values of the free magnetic particle do not actually conform to the case.

The free magnetic particle has of course still to report itself to the experimenter. If it exists, it is needless to add that our conception of matter, particularly the origin of magnetism, will be entirely revolutionized.

The Physical Laboratory, Allahabad University. M. N. Saha.

1. *Proc Roy. Soc.* ***133***

Nutrition and Academic Deficiency

Malnutrition is unfortunately too common among the students of Bengal and every effort should of course be made to remedy this defect in order to improve their calibre. An entirely different, and not altogether unimportant, problem however is whether those who are properly nourished do their best to achieve both physical and mental efficiency.

With a view to such an enquiry, the writer looked up the health record and the mark register of a particular college. The two items of defect from the health record *e.g.* "underweight" and "less chest expansion" have been taken to indicate lack of nutrition and want of proper physical exercise respectively. On the academic side, less than 40 p. c. of total marks has been arbitrarily chosen as indicative of deficiency. The academic data of the different classes cannot be combined, as the arbitrary standard of 40 p. c. marks does not indicate the same degree of proficiency for the different classes. A way out of the difficulty would have been to obtain the "median" marks for each class and use it as the standard, The procedure, however, has not been followed as the labour involved was not thought to be commensurate with the probable result.

From the data obtained on the basis of the above classification, the following tables have been formed and certain proportions worked out. (*Vide tables overleaf*).

The number of cases of the 3rd year science class is obviously so few that no reliance can be placed upon the results. Statistically the results of the 1st year class are found *not* to be significant.

The writer, however, believes that when a sufficiently large number of cases are examined the apparent implications of the above proportion may not be eventually found to be misleading. They are that underweight students show a slightly higher percentage of academic deficiency

TABLE I.

First and Third Year Science Classes combined.

	Less chest expansion		Chest expansion not less		Total
Underweight	34	..	15	..	49
Not underweight	15	..	6	..	21
Total	49	..	21	..	70

Proportion of students with less chest expansion among those who are underweight 69. 3 p. c.
Proportion among those who are not underweight 71. 4 p. c.

TABLE II.

First Year Science Class.

	Marks above 40 p. c.	Marks below 40 p. c.		Total
Underweight	7	21	..	28
Not underweight	5	10	..	15
Total	12	31	..	43

Proportion of academically deficient students among those who are underweight. 75 p. c.
Proportion among those who are not underweight 66. 6 p. c.
Also for the same class,
Proportion of academically deficient students in the whole population 72. 1 p. c.
Proportion among those who are underweight 75. p. c.
Proportion among those who are underweight and have less chest expansion 78. 2 p. c.

TABLE III.

Third Year Science Class.

	Marks above 40 p. c.		Marks below 40 p. c.		Total
Underweight	16	..	5	..	21
Not underweight	5	..	1	..	6
Total	21	..	6	..	27

Proportion of academically deficient students among those who are underweight 23. 8 p. c.
Proportion among those who are not underweight 16. 6 p. c.
Also for the same class,
Proportion of academically deficient students among the whole population 22. 2 p. c.
Proportion among those who are underweight 23. 8 p. c.
Proportion among those who are underweight and have less chest expansion 27. 2 p. c.

but no signs of less physical activity. One fact in connection with the question should not be lost sight of. Malnutrition is to be found mainly among the poorer classes of students, and it is they again who find less time and opportunity for studies, having to supplement their monthly allowance by private tution and other odd jobs. The slightly higher percentage of academic deficiency, then, may, more than fully, be attributed to this handicap. If it be true that the well-nourished students do no better than the under-nourished, one feels inclined to ask, "Are the former (who probably also represent the better-off section of the student community) *comparatively* more lethargic or apathetic towards both physical and mental exercises ?"

Now that health examination is a permanent feature in many colleges in Bengal, could not they co-operate in collecting data to obtain a definite answer to this question ? Educationists owe it to themselves to look about and to sound a note of warning when they catch any section of the student community napping.

Rajshahi College. Bimal Chandra Bhattacharjya.
2. 7. 35.

On the theory of the Surface-tension of Liquid Metals

It is well-known that the surface-tension of liquid metals is very much greater than that of other substances. For example, the surface tension of *Au*, *Pb*, *Hg* etc. is of the order of five hundred while for non-metals like sulphur, petrol *etc.* it is only about fifty. We have worked out, on the free-electron model of Sommerfeld and taking into account the Coulomb forces between ions and free-electrons and the Fermi Dirac distribution law for electrons, a theory of surface-tension of liquid metals. By a straight-forward applicaiton of the theory, we obtain the formula for surface-tension S,

$$S = \frac{1}{32} \frac{h^2 \beta}{\pi m m_H^{4/3}} \left(\frac{\varrho}{A}\right)^{4/3} + \frac{T}{4} \frac{dS}{dT}$$

where β is a constant, very nearly unity, but its exact value is to some extent uncertain ; ϱ is the density, A the atomic weight, T the absolute temperature, m the mass of the electron and m_H the mass of proton. Taking β as unity and for the present neglecting the small correction due to the term $\frac{T}{4}\frac{dS}{dT}$ we give below the calculated and observed values for a few metals. Better agreement is obtained by taking $\beta = 0.9$.

Metal	S (calc.) with $\beta = 1$	S (calc.) with $\beta = 0.9$	S (observed). Dynes/cm.
Na	329	294	294
Ag	924	825	800
Pb	498	445	444
Cd	781	697	630
Hg	668	596	465

The observed values are taken from the International Critical Tables. It may be noted that these values are not very reliable as different observers sometimes give widely different results: for example, in the case of Hg, Kaye and Laby's Tables (1932) give after Quincke the value 547. The value of the correction term $\frac{T}{4}\frac{dS}{dT}$ is uncertain as the data for $\frac{dS}{dT}$ are very meagre and even so not available in all cases. To obtain an idea of this correction we take the case of Hg where $\frac{dS}{dT}$ is found to be nearly 0.4 and so $\frac{T}{4}\frac{dS}{dT}$ will be about 30.

The above theory also explains some important properties of thin films *i. e.* the electric conductivity of very thin films is smaller than the conductivity of metal in bulk by a factor of (5-10). The full paper will shortly appear in *Phil. Mag.*

Physics Laboratory,
Delhi University.
15. 6. 1935.

D. V. Gogate (Boroda).
Duleh Sinha Kothari.

Evidence of Homopolar Binding in some Paramagnetic Chlorides

From a study of the magnetic properties and absorption spectra of solutions of paramagnetic salts of the iron group Datta[1] and others have come to the conclusion that in aqueous solutions the paramagnetic ions form hydrated complexes, while in alcoholic solutions or in solutions with high concentration of the negative ion the paramagnetic salts exist mostly in the form of undissociated molecules. In the latter case Raman lines corresponding to homopolar binding between the atoms forming the undissociated molecules are to be anticipated. The following is a preliminary report of the investigations undertaken to study the point. Some of the solutions are strongly coloured and any effect which might be present is masked by the strong absorption of the solution. In other cases Raman lines have been obtained. A Hilger E_2 quartz-spectrograph was used with slight coma on the Stokes side of the main line; but the modified lines are outside this region.

Solute.	Solvent.	Colour of the solution.	$\Delta\nu$.	Remarks.
Manganese chloride	63% HCl soln	Colourless when dilute	125 cm⁻¹	From Hg line 4358
Cerium Chloride	„	Colourless	146 cm⁻¹	„
Nickel Chloride	Absolute alcohol	Deep green	—	Strong absorption
	63% HCl sol.	„		„
Cobaltous chloride (Both anhydrous and hydrated)	Do	Deep blue	—	„

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1 *Phil. Mag.*, *17.*, 585, 1160 (1934).

Synthesis of isoNitrosothiocamphor : Its Application as an Indicator and as an analytical Reagent

iso Nitrosothiocamphor has been prepared by the action of isoamyl nitrite on thiocamphor in presence of sodamide. It is a bluish violet crystalline solid melting at 148°C. It is sparingly soluble in water and mineral acids but readily

soluble in common organic solvents like alcohol, ether, benzene, acetic acid etc., and is easily crystallizable from alcohol. Though it is a thioketone, yet it is practically odourless unlike other thioketones. The substance is easily soluble in caustic alkalies giving red coloured solutions which when diluted change to yellow. In a very dilute aqueous alcoholic solution its violet colour practically vanishes, and the solution seems to be colourless. It also forms a green coloured benzoyl derivative. The formation of *iso*nitrosothiocamphor from thiocamphor itself and the properties described above lead to its constitution, which can be represented as

$$C_8H_{14}<\begin{matrix}C{:}NOH\\ |\\ CS\end{matrix}$$

, in which the hydrogen attached to NOH is easily replaceable. This also suggests that the reactivity of the methylene group adjacent to the thiocarbonyl group in thiocamphor is similar to that in camphor adjacent to the carbonyl group. The colour change of *iso*nitrosothiocamphor in acids and alkalies has rendered it useful as an indicator in acidimetry and alkalimetry. Its range is very short and lies between p_H 8.6 to p_H 9, p_K being 8.8. This compound is very interesting as being the first compound of the series to be used as an indicator. Its sensitive colour change can be utilized more accurately for alkalimetric titrations owing to its short range unlike other indicators whose range is always found to be greater than 1. It can be used for the estimation of caustic alkalies, and also of mineral and organic acids including phenolic acids and the latter can be estimated both in aqueous and alcoholic solutions.

Another important application of this substance lies in its formation of a deep red cobaltic complex

$$Co\left[C_8H_{14}<\begin{matrix}C{:}NO\\ |\\ CS\end{matrix}\right]_3$$

insoluble in dilute acetic acid. With nickel it forms a greenish brown complex soluble in the same acid. This has been utilized for the quantitative estimation of cobalt in presence or absence of nickel by direct weighing. It is also a sensitive qualitative reagent for cobalt which can be detected in aqueous solution up to the extent of 1 part of cobalt in 50,000 parts of water. The detailed studies of the reagent will be published in the *Journal of the Indian Chemical Society*.

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Calcutta.
27-6-35.

Ascorbic Acid in Cocoanut Water and Kernel

While examining the vitamin C content of certain Indian foodstuffs, interesting results were obtained with cocoanut. It was found that cocoanut water contains significant amount of Vitamin C before formation of the kernel in the fruit. The ascorbic acid content of its water increases with maturity of the fruit till the ascorbic acid concentration reaches its highest, when the ascorbic acid concentration of the kernel equals that of the water. Henceforth as the fruit ripens the quantity of kernel increases as also its ascorbic acid concentration whereas that in water gradually diminishes. In a fully ripe and dry fruit the ascorbic acid of the water practically vanishes. The kernel is rich in Vitamin C even to the point of advance germination. Fruits from the same plant in our own garden in one season were examined as also other fruits from the market. Details will appear in the *Transaction of the Bose Institute*.

		Mg of ascorbic acid for 10 cc. water	Mg of ascorbic acid for 10 gms. kernel
Average of six samples	Immature fruit without kernel	0.1325	......
"	Half mature fruit with soft kernel	0.190	0.160
"	Mature fruit with semi-hard kernel	0.22	0.225
"	Ripe fruit freshly plucked hard kernel	0.20	0.3575
"	Ripe and dry fruit with embryo	Nil (less than 0.03)	0.275

Bose Institute,
93, Upper Circular Road, Hirendra Nath Banerjee.
Calcutta.
10. 7. 1935

A New Species of Gregarious Spider Mimicking Camponotus Compressus

Naturalists have at different times recorded descriptions of gregarious spiders, drawing special attention to their peculiarities of habits.[1] A new species of gregarious spider has been found very recently in the vicinity of the Bose Research Station at Falta near Calcutta in a furrow of the trunk of a young banyan tree (*Ficus Bengalensis, Linn.*). The spider is very small and velvety black in colour, and shows a peculiar resemblance to the common black ants *Camponotus compressus* in general appearance as well as in colour. Particularly, it selects a place of shelter where these black ants are in abundance. They generally live on these black ants, and this may be a case of aggressive mimicry. The spider seems to be of the genus *Micaria* of the sub-family *Micariinæ* (*Fam. Drassidæ*) and is described here under the name *Micaria faltana*. *Sp. Nov.*

Dorsally the cephalothorax is raised along the central portion and evenly inclined on either side of it. The posterior portion of it is much broader. Eyes are arranged in two rows. The anterior row which is scarcely recurved possesses four eyes which are slightly bigger in size than those of the posterior one. The posterior row also possesses

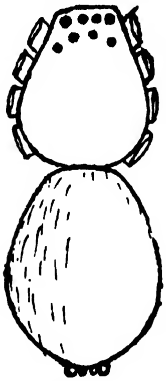

Fig. 1 Dorsal view of *M. faltana.* Fig. 2 Epigynum of *M. faltana.*

four eyes and is strongly recurved as well. (Fig. 1) The eyes of the anterior row have a dorso-lateral and those of the posterior row a dorsal aspect. All eyes are homogeneous and of dark brown colour. The cephalothorax is lower than the abdomen, which is oval and covered with black hairs. Four spinnerets are visible from above.

Ventrally, in the centre of the epigastric fold, the genital opening is found covered with a hard and complicated armature, which is again sharply divided by a broad median line like an inverted arrow. (Fig. 2).

Mandibles are unicate and covered with sparsely distributed black hairs.

Legs are very strong and covered with black bristles but thinly armed with spines. Femurs of the 1st and 2nd pair of legs are broader than those of the other legs. Tarsal scopulæ are present only at the tips of tarsi.

Measurements in mm. Total length—7; 1st pair of legs—6 5; 2nd pair—5.5; 3rd pair—4; and 4th pair—7.5.

The male bears a similarity in appearance with the female, as described above, excepting that it is slightly thinner and shorter in size than the latter.

Bose Institute,
93, Upper Circular Road,
Calcutta.
10th July, 1935

Gopal Chandra Bhattacharjee.

1. McCook—*Am Spider and their Spin, Work,.* *2* 230-241, Ibid, *3* 35-43.
Rev. O. P. Cambridge-*Proc. Zool. Soc. Lond.* pp 34;42 1889'
E. Simon—*Soc. Ent. de Fracn.* 1891.
Don Felix de Azara—*Voyages dans L' Amerique Meridionale—T. I.* p, 212. (Walcknaer's Fr. Ed.),
Darwin—*Voyages of Beagle 3* Zool.

Please read "*May*" in place of "*March*" in the July issue of Science and Culture P.71 line 3 in the article on The Quetta Earthquake.

Indian Science News Association

FOUNDED—1935.

The Inaugural Meeting
of the
Indian Science News Association

The Inaugural Meeting of the Indian Science News Association was held on July 9, at 5. 30. P. M. in the hall of the Calcutta Mathematical Society, University College of Science. More than 500 invitations were issued; about 250, including almost all the distinguished educationists, scientific men, and others prominent in public life, attended. Letters were received regretting absence due to unavoidable causes from—

Sir L. L. Fermor, Dr. J. C. Ghosh, Lt. Col. Russel, Dr. Wali Mahammad, Messrs. J. A. D. Naroji, P. N. Banerji, P. Parija, Major-Gen. C. A. Sprawson, Dr. Strickland, R. Sarkar, Sir. H. S. Paul, Dr. Baini Prasad, Mr. F. Tymms, Mr. C. G. Trevor, Lt. Col. Mc Gregor, Mr. C. Pastricha, etc.

Sir Prafulla Chandra Ray presided over the meeting.

The Vice-Chancellor, Mr. Shamaprasad Mookerjee was to have welcomed the guests, but as he was unavoidably absent, his speech was read by Prof. S. C. Ghosh, Secretary of the Post-graduate Council in Art and Science.

In welcoming the guests, the Vice-Chancellor said,—

The object for which the Indian Science News Association has been started has been explained in the first editorial of SCIENCE and CULTURE, the organ of the Association. Our intention is to place the knowledge of science within easy reach of the public and to advocate its application to all walks of life as far as practicable, and to afford the scientific workers in India an organ whereby they can express their views not only on the subjects of their special investigation, but also on measures likely to affect the life of the people. I think, gentlemen, you will agree with me that the stage is passed when we thought it worthwhile to dilate on what science has achieved for us. I can do no better than quote the following words from an American historian :—

"It requires a great effort to imagine our present world, with its factories, railways, steamboats, telephones, aeroplanes, and radio, to have been, at any other time, different from what it is to-day. Yet these wonderful mechanisms are but a century old, and the product of a great change in human affairs known as the *Industrial Revolution*. Until its advent the economic life of the world for countless ages had been much the same. A Greek of the time of Pericles, coming to France in the reign of Louis the Fourteenth, would have seen little to astonish him in the method of farming, manufacturing, trading, building, and transportation. Should he, however, come to America of the twentieth century, he would literally believe himself to be in an enchanted world. He would see things made with lightning rapidity by machines, wheat cut and the sheaves bound without human labour, vehicles speeding along without horses, ships moving through water without sails, houses brilliantly lighted without lamps, bird like contrivances flying in the air, and hear and see some one speaking thousands of miles away."

The term 'revolution' is generally applied to a popular uprising that is characterized by violence of speech and action. During the economic revolution, no speeches were made, no conventions were held, no battles were fought. Nevertheless this silent change, by altering radically the conditions of life for millions of human beings, may be truly regarded as the greatest of all revolutions in history, and as marking the end of the civilization of the past and the beginning of the civilization of the present and the future. "It was revolution," a modern writer says, "which has completely changed the face of modern Europe and of the new world, for its introduction of a new race of men—the men who work with machinery instead of with their hands, who cluster together in cities instead of spreading over the land in villiages and hamlets; the men who trade

with those of other nations as readily as with those of their own town, the men whose workshops are moved by the great forces of Nature instead of by human hand, and whose market is no longer the city or the country, but the world itself."

We in India, frankly, have never liked these changes. But whether we like it or not, the great revolution has not spared us. It has radically altered the conditions of life of the teeming millions of our country, not only in the cities, but even the remote villages which remained practically unaffected by the numerous political revolutions of the last thousand years, have been succumbing to the new revolution. Gone are the self-sufficient village industries and organizations and the time honoured village institutions, and it is very doubtful whether, inspite of recent heroic efforts in certain quarters, they can ever be revived. Even agriculture, the traditional occupation of the villager, has not escaped the effects of the revolution. Only a few years ago, many of the agricultural industries, like the sugar industry, in which India was predominant from immemorial times, were almost completely wiped out owing to the perfection of new methods of manufacture, used in Java and elsewhere, which owed their origin to scientific research.

It is therefore clear that we can no longer follow our ancient ways of life, but must move with the times. This has been rendered difficult owing to scanty knowledge of science and modern conditions, and dearth of scientific workers in our country. In fact, before the great scientific pioneers of our country, Sir P. C. Ray and Sir J. C. Bose, began their works, science was not much cared for in this country, specially by our conservative public. These pioneers, who are still happily with us, and the two generations of students whom they trained and who are now occupying distinguished and responsible positions in the country, have brought the light of science to us. But though Indian science now occupies an honoured place in the world, it is common knowledge that there is no proper and powerful organization for placing the knowledge of science within the easy reach of the public. In other countries this is done in a variety of ways, by popular scientific magazines, properly organized educational museums, films, lectures etc. In this way science is brought within easy reach of the men with ordinary education, and it not only improves the general level but sometimes leads to discoveries of great industrial importance. If science were confined only to the universities, there would never have been a Faraday, an Edison, or a Marconi, none of whom were a university man.

There is another line in which such a journal will fulfil a very useful purpose. We all feel how dependent we are on industries, based on science, like the electrical industries, the railway, the mining and the chemical industries. These are indispensable for life, but it is wellknown that from their very nature they can be organized either by the State or by huge industrial concerns which, for public good, should be under strict supervision of a powerful body of scientists, engineers, and officials, organized by the State. It is also well known that on account of dearth of knowledge amongst our public men, and due to other political causes, these industries have mostly passed under bodies, which are pure and simple profiteering concerns.

The Indian Science News Association has been founded not only with the object of placing within easy reach of the public a knowledge of modern science, but also for expressing intelligent and unbiassed opinions on such industrial measures which are likely to affect our everyday life. "SCIENCE AND CULTURE", of which the first two issues are before you, is its first venture, but we hope that when we have established our claim on the public by giving proper service, other lines of activity would be developed for the furtherance of the broad purpose we have in view.

I would further remind you that there is no other place in India which is more suitable for the publication of such a paper than Calcutta, the second city of the British Empire. Calcutta has been the home of science ever since the advent of the British rule. Here was founded, one hundred and fifty-two years ago, the Mother of Indian Scientific Societies, *viz.* the Asiatic Society of Bengal. This city saw the birth of the various scientific services of the Government like the Meteorological, the Geological, the Agricultural, the Zoological, and the Botanical, most of which are still happily in Calcutta. The Calcutta University was the first amongst Indian Universities,

to organize teaching of science in the country, and has got the largest number of chairs in the scientific subjects founded by the benefactions of private individuals, as well as of the Government.

In recent years, a large number of scientific societies have been started at Calcutta, culminating in the foundation of the National Institute of Sciences of India, which in conjunction with other academies and scientific societies is to function as the National Academy of Science for India. Calcutta can justly boast of the largest number of scientific workers in every branch of science and as regards scientific activities, no other city in India comes within its measurable distance. The Indian Science News Association will thus get first hand support from numerous bodies of scientists at Calcutta, and of course it is also trying to enlist the support of the scientists in the other educational and research institutes.

I have only to tell you of the amount of support we have got for our Association.

The Indian Science News Association started with the gift of a thousand rupees from our distinguished townsman, Sir Upendra Nath Brahmachari. Let us hope that Sir Upendra Nath will further unstring his purse for this cause. Our first President, Sir Prafulla Chandra, has kindly promised us two thousand rupees, and a gentleman who prefers to remain anonymous a princely sum of six thousand rupees. We hope that other patriotic countrymen of ours will emulate these donors in coming to our aid.

I have further much pleasure to announce that the Association has entered into an understanding with Mr. Hari Keshava Ghosh and his brothers, proprietors of the wellknown publishing house of The Indian Press Ltd. for printing of the journal SCIENCE and CULTURE for a period of two years, free of cost, if necessary. Two issues of the journal are already before you, published in time which will tell you that the printing is in very efficient hands. We have secured a very enthusiastic and qualified band of workers, and I can tell you that to me a glorious future of the Association seems to be assured.

Prof. M. N. Saha said on behalf of the Organizers :—

The Vice-Chancellor has very lucidly set forth before you the objects with which our new Association has been started, and I have very little to add to these remarks. I remember the occasion when nearly twenty years ago, our great countrymen, the late Sir Ashutosh Mookerjee, laid the foundation stone of this great College of Science with the splendid donations which he was able to secure from Sir T. N. Palit and Sir Rash Behari Ghose. His object was to provide a Temple of Science where facilities would be given to Indian workers to dedicate their lives to the cause of science.

The history of the last twenty years has amply justified the wisdom of the course of action pursued by the great founder of this institution. It is now universally admitted that the work of the University College of Science gave a great impetus to the cause of science in India, and the contributions from its laboratories have won honoured recognition all over the world. At present in emulation of the start given by the College of Science many other centres of scientific activity have grown up in other provinces and cities, but the impetus given by the University College of Science will remain a landmark in the history of progress of Science in this country.

But I recall also, on this occasion, some unfulfilled wishes of our great founder. His programme was not confined merely to the foundation of a laboratory for the scientific workers, but he had a further plan of bringing the knowledge of science within easy reach of the public, so that our country may be culturally and economically benefited by the application of scientific knowledge to all walks of life. No doubt a great step towards the realization of this aim has been taken by adoption of a programme of the teaching of science in the vernacular in the high schools of this country. Our present venture, I may add, further brings to completion the programme, started by the late Sir Ashutosh Mookerjee.

Sporadic efforts have indeed been made from time to time, by journals and certain associations, to fulfil the aforesaid objects, but this is probably the first organized effort for seriously tackling the problem. This is the first occasion

when active scientific workers have taken upon themselves the task of performing this duty to the public.

The Indian Science News Association has been formed with the object of popularizing and spreading the knowledge and progress of modern science, and it hopes to do so by publication of journals of different classes, and later on, when funds permit, by organizing public lectures.

The promoters of the organization have been lucky to secure as its first President Sir Prafulla Chandra Ray. I need hardly describe him to you, Always the first and foremost to help a good cause, he has not only lent us the powerful weight of his name and the benefit of his guidance, but has also come forward with a substantial contribution to our funds. We have further been lucky to have as our Vice-presidents our present Vice-Chancellor, in whom the spirit of Sir Ashutosh lives again; Sir Upendra Nath Brahmachari whose researches in kalaazar have saved millions of men from an early grave; Dr S. C. Law, the millionaire scientist of this city and a lifelong devotee to the science of ornithology, and a great enthusiast for the propagation of scientific knowledge. The vernacular journal, *Prakriti*, which he is publishing for the last twelve years, is ample testimony to his enthusiasm and liberality. The Association will consist of *patrons* and *life members* and will be governed by a council elected according to registered societies' rule, and the members of the Association shall not claim any share in the profits which the Association may make in its undertakings. Our first council, which is merely provisional, consists of comparatively younger workers in every branch of science, in this city, with powers to co-opt. This will be done gradually as we recruit more members from outside. Though Calcutta has taken the lead in founding the Association, it will try to enlist the co-operation of the scientists in other parts of India and thus make the organization an all-India body.

The Association has undertaken for the present the publication of a monthly journal, SCIENCE AND CULTURE two issues of which are already before you. It has also got plans for starting vernacular journals, and a school science journal when the funds permit.

The Association has entered into an understanding with Mr. H. K. Ghosh and his brothers, proprietors of the well-known publishing concern, The Indian Press Ltd. of Allahabad and Calcutta, whereby they have undertaken to publish the journal for two years on terms that completely ensure its publication for two years. It was very kind of Mr. H. K. Ghosh, the present head of the firm, which has established a name for efficiency and sterling business honesty, to have spontaneouly come forward with this offer for help in our cause, Mr. Ghosh is now in Europe; but his brothers are, true to the traditions of their house, fulfilling the undertaking given by him with scrupulous care and fidelity. They have already got new types from Europe, and you will find a much better get-up for the next issue of our journal. Though our understanding is at present binding only for two years, and the contracting parties have reserved to themselves the right of revising it after the expiry of that period, we hope that the contract will endure for longer periods.

Sir P. C. Ray's presidential remarks:

Sir P. C. Ray in the course of the speech said that India was intellectually and culturally great even 10,000 years ago, and even in very ancient times she carried on scientific investigations. But unfortunately darkness fell on India soon after and it is only very recently that the dark veil is being gradually lifted. When Sir J. C. Bose read his first scientific paper he was quite nervous, but now those days are gone and numerous Indian scientists are facing learned gatherings all over the world with the reports of their scientific works. Even a large number of Indian women are working side by side with male students in the laboratories.

Regeneration of India has begun, but if she has to get back her old position, it is only possible through the study of science and spread of scientific knowledge. Japan has worked miracles during the last 50 years by application of science in all walks of her national life, specially to her industries. She has even beat the most advanced countries of the West in manufacturing daily necessities by scientific methods.

We are indebted to Europe for bringing

back the scientific spirits to India after a long dark period. They were leaders even in Indian archaeology and study of scriptures. But as it ought to be, Indians are gradually coming to the front, but we still welcome their co-operation.

Proceeding Acharya Ray dwelt on the necessity of a journal like Science and Culture, which is the first activity of the Indian Science News Association. In England there are a number of journals which help to propagate scientific knowledge among the public.

Indian Science News Association requires a large fund for carrying out their objects. A sum of one lakh of rupees must be raised for this purpose. I hope a large number of public spirited men with a love of science at heart will come forward to help this Association, and the sum of one lakh will be raised in no time. I again request our countrymen to respond generously to the appeal of the Indian Science Association.

Prof. Saha then read the composition of the *first provisional council* :—

President	Sir P. C. Ray.
Vice-Presidents.	Mr. S. P. Mookerjee. Sir U. N. Brahmachari. Dr. S. C. Law.
Secretaries.	Dr. M. N. Saha. Dr. B. B. Ray.
Treasurer.	Dr. N. R. Sen.

The names of the members of the Council will be published later. At present it has got 12 members who represent as many different branches of knowledge as possible. Another will be coopted later.

THE INDIAN SCIENCE NEWS ASSOCIATION

FOUNDED IN 1935

Memorandum of Association

The rules are only provisional. They will come into operation from the 1st of Januray, 1936, and shall be revised in a final form by the Council before July, 1936, before the Association is finally registered according to Act IX. of 1861. The registration of the Association shall not be postponed later than September, 1936.

The Indian Science News Association

Founded in 1935

Memorandum of Association

A. Name & Objects

1. The name of the Association shall be THE INDIAN SCIENCE NEWS ASSOCIATION.

2. The objects of the Association are :—

(*i*) To popularize and disseminate the knowledge and progress of natural and cultural sciences.

(*ii*) To publish journals, books and organize lectures both in English and vernacular in furtherance of the objects set forth in (*I*).

(*iii*) To secure and administer funds, grants, and endowments for the furtherance of the objects of the Association.

(*iv*) To undertake and execute all other acts which shall assist in, and promote, the usefulness, aims, and purposes of the Association.

B. Constitution

3. The Association shall consist of Patrons, Life-Members, and Honorary and Corresponding Members.

Hereinafter "Members" of the Association shall denote Patrons and Life-Members and Members nominated by Patrons.

4. PATRONS :—Shall consist of persons, firms, Corporation, or Associations, contributing Rs. 1000/- or more to the funds of the Association.

5. Life-Members shall consist of persons, and educational and research institutions, who shall contribute Rs. 100/- or more to the funds of the Association.

6. Honorary Members shall be persons well-known for their qualifications in, or services to the cause of, natural and cultural sciences. The number of Hony. Members elected per year shall not exceed two and the total number shall not exceed thirty.

7. Corresponding Members shall be persons who have rendered conspicuous services to the Association by contributing articles etc. to its journal or in other ways.

8. All classes of Members of the Association shall be entitled to the following rights and privileges :—

(*a*) To be present and vote at all meetings (general).

(*b*) To propose and second candidates for Life-Membership.

(*c*) To receive one copy of SCIENCE AND CULTURE free and of such other publications of the Association as the Council may determine from time to time.

(*d*) To have personal access to the Library and other public rooms of the Association, subject to regulations to be prescribed by the Council.

9. Patrons and Life-Members alone are entitled to fill any office in the Association on being duly elected thereto.

10. Patrons shall have the right to nominate five persons, who on approval of the Council will be treated as life-members without paying any dues.

C. Election of Life-Members

1. Candidates for Life-Membership and nominations by the Patrons shall be proposed by one and seconded by another Member of the Council of the Association. The names of the candidate, his proposer and seconder shall be laid before a meeting of the Council, and if approved, the candidate shall

be recommended for election by ballot at the next meeting of the council, and published in the next issue of SCIENCE AND CULTURE for information of the members of the Association, and if there is a requisition by at least five members of the Association for postponement of the election given in writing to one of the secretaries at least one week before the next meeting, the recommendation shall be referred back to the Council for reconsideration. If the Council reaffirms its previous decision the approved candidates shall be ballotted for at the next meeting of the Council.

2. Those candidates shall be deemed to be duly elected, in favour of whom not less than two-thirds of the Members present at such council meetings have voted.

3. The Secretary shall send a written announcement of their election to the candidates who have been duly elected, and shall therewith send a copy of the rules for the time being in force.

4. No person, although elected according to the foregoing rules, shall be entitled to exercise the rights and the privileges of Membership, nor shall his or her name be entered into the list of members, until he or she has paid the Life-Membership fee within one year of his or her election.

5. The full payment of Life-Membership fee shall be the commencement of effective membership.

6. The preceding two rules shall be written or printed on the letter of announcement of election sent to Members by the Secretary.

7. Honorary and Corresponding Members shall be proposed at any Meeting by the Council, which shall, at the same time, state the grounds on which the recommended election is proper or desirable. The persons so proposed by the Council shall be ballotted for at the next meeting of the Council, and during the interval, their names shall be communicated to the Members of the Council. It shall be necessary that three-fourths of the members present at the meeting where such election takes place, vote in favour of the candidates.

D. The Council and its Officers

The administration, direction, and management of the affairs of the Association shall be entrusted to a Council composed of the following members of the Association :—

(1) President,

(2) Vice-Presidents, whose number shall not exceed five,

(3) One Treasurer,

(4) Two Secretaries,

(5) Members, whose number shall not exceed twenty or should not be less than twelve.

The President, the Treasurer, and the Secretaries shall be called the officers of the Association. The election of the officers and other members of the Council shall take place at the Annual Meeting of the Association. The retiring officers and the members of the Council shall be eligible for election, but no office shall be held by the same individual for more than three successive years with the exception of the offices of the Secretaries and the Treasurer. The Secretaries shall have to retire after they have held office for a maximum period of four years.

The Treasurer and the General Secretary shall hold office until a successor has been appointed.

The Council shall, by the 1st July each year, nominate by ballot not more than twenty nine and not less than twenty one members (of whom at least four shall be such as are not officers or members of the existing Council), whom the Council recommends to the Association for election to the Council for the ensuing year. The Council shall also nominate by ballot, out of the proposed members of the new Council, the person whom it recommends to to the Association for election to the place of the President, two Vice-Presidents, the Treasurer and the Secretaries.

The Secretaries shall prepare a list of such persons, whom the Council recommends to be elected as President, Vice-Presidents, Treasurer, Secretaries, and other members of the Council for the ensuing year, and before the 1st October such list shall be printed in SCIENCE AND CULTURE and circulated among the members of the Association as voting paper, which shall bear a blank column opposite to the list of the names for such alterations as any member may wish to make.

The members shall then vote for the offices and the places in the Council to be filled up by placing a cross against the names of those they wish to be elected.

The voting paper shall be enclosed unsigned in a sealed envelope supplied by the Association, which shall be forwarded to the Secretary in an outer cover with a covering letter signed by the member, so as to reach the Assocn. by the third week of September. In the absence of a covering letter, the voting paper shall be invalid.

The sealed envelope shall be placed by the Secretary in the Annual Meeting and opened.

Two scrutineers shall be appointed by the President, with the approbation of the majority of the members present.

The scrutineers shall examine the voting papers and report to the President the names of those having a majority of votes, and these names shall be announced from the chair.

In the event of a vacancy occurring during the year in the office of the President, Vice-Presidents, Treasurer, Secretary or Member of the Council, it shall be competent to the remaining members of the Council to fill up such vacancy, subject to the confirmation of the next General Meeting of the Association to be called for the purpose in accordance with rule.

If, for any reason, the Officers and the Members of the Council should not be appointed for the ensuing year in January, the Officers and the Members of the Council elected during the previous year shall continue to hold office until their successors shall be duly elected.

The powers and the duties of the Council shall be as follows :—

(*a*) To manage the affairs of the Association, and, for such purpose, to make such regulations as may appear to them conducive to the good administration of the Association and the attainment of the object of its foundation, provided always that such regulations be not inconsistent with anything contained in these rules, that they be reported for the information of the next General Meeting, and that they be subject to rescission or alteration by the Council or by any General Meeting;

(*b*) To superintend and direct the publication of the proceedings or other works published by the Association ;

(*c*) To appoint as many salaried officers, clerks, or servants, as they may deem necessary; to define their duties, allowances, salaries, gratuities, and privileges, and to suspend or dismiss them, or to dispense with their services, as occasion may require ;

(*d*) To exchange for other property, or otherwise dispose of, in such a manner as may, in their opinion, best conduce to advance the objects and interests of the Assocn. any duplicate books, maps, specimens, etc., belonging to the Association ;

(*e*) To prepare and submit to the Annual Meeting a report on the general concerns of the Association. Such report shall set-forth the income and expenditure for the calendar year, the balance in hand, the debts and assets, the estimated income and expenditure of the succeeding year, the prosperity or otherwise of the Association, and the progress of the Library. The report shall also include an abstract of the proceedings of the Council during the year.

The powers and duties of the President shall be as follows : –

(*a*) To preside at all meetings of the Association and of the Council and to regulate the proceedings at such meetings ;

(*b*) To ensure due effect being given to these rules, and to the regulations made by the Council ;

(*c*) To be ex-officio member of the Committees appointed by the Council.

The duties of the Secretary shall be as follows :—

(*a*) To conduct the correspondence of the Association and of the Council, and to sign all the letters and papers emanating from the Association ;

(*b*) To attend the meetings of the Association and of the Council, to take minutes of the

proceedings of such meetings during their progress, and, at the commencement of such meetings, to read the minutes of the previous meeting;

(c) To announce the presents made to the Association since their last meeting, to read the names of the candidates for membership and the letters addressed to the Association;

(d) To prepare for submission to the Annual Meeting a list of members, corrected to the close of the previous year;

(e) To enter or cause to be entered, in the minute books, all the proceedings of the Association and of the Council before the following meeting, and to see that all papers and letters and documents of every kind connected with the business of the Association are properly filed and reserved;

(f) To edit the publication of the Association;

(g) To exercise general supervision over the servants and affairs of the Association, and to assist in carrying out these rules and regulations and orders made by the Council.

The Treasurer shall receive and hold for the use of the Association all moneys paid to the Society; he shall disburse all sums due from the Association, and shall keep exact accounts of all such receipts and payments. Disbursements exceeding Rs. 100/- shall be made by order of the Council, or of a Committee of the Council, under signature of the Chairman of the meeting at which the order was passed. The Treasurer shall be ex-officio member of all Committees appointed by the Council and shall be the Chairman of the Finance Committee.

The following shall be applicable to all meetings of the Council :—

(a) Five members shall constitute a quorum;

(b) The President or, in his absence, one of the Vice-Presidents shall take the chair; if neither the President nor one of the Vice-Presidents be present on the expiration of fifteen minutes after the hour fixed for the meeting, the members present shall elect the Chairman;

(c) The business of each meeting shall be proceeded within order hereinafter prescribed in rules, provided always that, on written notice being given to the President or Secretary, not less than 48 hours before the hour of meeting, a motion for the immediate transaction of urgent business may be made, and if such motion be seconded and carried, this rule shall be suspended;

(d) With the exception mentioned in the last rule, notice of motion on any matter of importance shall be given at the Council Meeting preceding that on which the subject is to be disposed of, in order that members who take an interest in the question may have an opportunity of informing themselves regarding it and expressing their assent or dissent; shall be carried at the meeting at which it is proposed, unless the President or the Chairman of the meeting rules that it should be postponed;

(e) All motions and amendments shall require to be seconded otherwise they cannot be put. Amendments must be in writing, unless excused by the Chairman. Not more than a single amendment to the original question or amendment to an amendment shall be laid before the Meeting at one time. When any such amendment has been negatived, or has been allowed to take the place of the original motion, other amendments involving fresh points may be proposed;

(f) Each Council Member present is entitled to speak once, and once only, to each substantive motion and to each amendment. Nothing in this rule shall be construed to prevent any Council Member from addressing the Chairman on a point of order, or to prevent the mover of original motion, with the permission of the meeting from speaking a second time by way of explanation or reply.

Communication of members not present, on subjects to be submitted to vote cannot be read, unless by consent of the meeting ;

(*g*) The usual method of voting shall be by show of hands ; provided always that the votes on any particular subject may be taken by ballot on a motion to that effect duly carried ; and, in the cases specially provided for by these rules, the votes shall be so taken ;

(*h*) The Chairman's decision on the show of hands shall be final unless a division be called for. It shall be competent to any Council member present to call for a division ;

(*i*) The Chairman shall not vote with the rest of the Meeting but when the votes for and against are equal, he shall have a casting vote ;

(*j*) Any Council Member shall have the right of recording his protest, together with the reason for the same, against the decision of the majority upon any question, provided that such protest be forwarded in writing to the Secretary before the next Council Meeting. Such protest shall be published in the proceedings of the Association.

A General Meeting shall ordinarily be called once a year, but extra-ordinary meetings may be called under the orders of the Council, or on requisition signed by at least 20 ordinary members of the Association, or by the President acting on his own initiative.

The order of business at such meetings shall be as follows :—

(*a*) The minutes of the last General Meeting shall be read, and if found to be correct and not to involve any contravention of these rules, they shall be confirmed by the meeting and signed by the Chairman. If objected to on the ground of incorrectness, they shall be amended on motion made and carried to this effect ;

(*b*) The presents made to the Association since their last meeting shall be announced and exhibited ;

(*c*) Reports and communication from the Council shall be submitted for consideration ;

(*d*) The Chairman shall announce the names of new members elected within the preceding year.

Meetings of the Council and of Committees appointed by the Council :—

(*a*) Meetings shall be held ordinarily once a month ;

(*b*) The President or any four Members may call a special meeting, giving 48 hours notice to all other members ;

(*c*) The ordinary method of voting shall be carried by show of hands, but the votes shall be taken by ballot on motion to this effect duly carried, or when these rules provide for such method of voting ;

(*d*) The Chairman shall not vote with other Members, but when the votes are equal, he shall exercise his own ;

(*e*) Minutes of the Proceedings of every meeting of the Council shall be taken during their progress by the Secretary or the Asst. Secretary (if appointed) or in their absence by some menbers present whom the Chairman shall appoint for the occasion. The minutes shall be placed by the Secretary at the next meeting of the Council for the purpose of confirmation.

The Council may elect, from among their own body, Committees or Sections for the consideration of special subjects. They may also appoint Honorary Fellows or Ordinary Members other than Members of the Council, who are competent as well as versed in the subjects to be referred to these Committees, to be Members of such Committees.

Committees shall cause Minutes to be taken of their proceedings. They shall report to the Council on all matters referred to them, producing such minutes, if called for.

SCIENCE & CULTURE

A MONTHLY JOURNAL DEVOTED TO NATURAL & CULTURAL SCIENCES

Vol. I September 1935 No. 4

Germany's Organization for Research

—The Kaiser Wilhelm Society

In a separate article we publish a brief abstract of the account of the activities of the Kaiser Wilhelm Society for Advancement of Science published in the Natur-wissenschaften of the 28th June, 1935. It may be added for the information of our readers that this is a society founded in 1911 under the personal initiative of the ex-Kaiser Wilhelm II, with the object of creating facilities for promising workers in Germany for scientific investigations.

The society has at present under its control a string of about 20 research institutes which are distributed over the whole of Germany, and its scientific activities extend over all branches of knowledge from investigations on coal to German cultural history. It will not be out of place, for the information of the readers of SCIENCE AND CULTURE, to give a history of the foundation and activities of this important research organization which has played such a great part in recent years in Germany's history, in war as well as in peace.

German science and organization are held up to-day as models of efficiency and usefulness to the state as well as the public, but barely three generations ago, the world opinion on Germany was far from complimentary. Probably many of the readers of SCIENCE AND CULTURE are aware of George Henry Lewes's wellknown story, written in the sixties of the last century, of the professor who had three students belonging to three nationalities *viz*. English, French, and German; how the professor, in order to test the efficiency of the students, asked them to write an essay on the camel. The story-teller makes the English student take a trip to Arabia, study the life of the camel for a year, and then submit a report written in rather rough and inelegant language but containing first-hand observation on the life-story of camels; he makes the French student run to the best libraries in the world, consult all the literature on the subject, and write the essay in a language possessed of highly artistic grace and literary flourish. But what did he make of the German? He neither takes a trip to the country of camels nor to any library, but shuts himself up in his study and evolves out of his mental consciousness a grand philosophical theory of the camel. This story which would now be taken as a joke was supposed to represent well, at the time when it was written, the national characteristics of the three great nations who are now in the front rank of civilization and who have created amongst themselves almost the whole of modern culture. There was no doubt that before and about

1860 Germany had produced great leaders in Science and Thought. It would have been futile to deny the greatness of a Gauss or a Humboldt in science or the profundity of the thinking power of a Kant, Hegel, or Schopenhauer. But Germany's reputation as an industrial nation was indeed not very high. She was the last to take advantage of the "Industrial Revolution" which since 1800 was slowly transforming people in England and France from agricultural to industrial and urban communities.

But since 1871 when German unity was achieved, her rise as an industrial nation was almost phenomenal. The Germany of 1914 had the biggest resources, of all European nations, in coal and iron, the two greatest requisites for industrial development, as well as in other minerals, and potentially she was a much more powerful nation than France or Italy, even England not excepted. This is exemplified in the production of coal and iron in the different European countries for a number of typical years as shown below before and after the Great War.

PRODUCTION OF PIG IRON AND STEEL IN LACS OF TONS

The first figure refers to iron; The second figure refers to steel.

Year	Great Britain	U. S. A.	Germany	France
1865	49+2·2	8·4+·13	9·9+·97	12+·40
1875	64+7·2	20+3·96	20+3·70	14+2·56
1885	73+20	41+17	37+12	16+5·6
1895	80+34	96+62	58+39	30+9
1905	97+59	233+203	109+100	31+22
1912	90+67	302+317	178+178	48+41
1925	62+61	367+454	100+121	83+72

Observe that the production of Great Britain is nearly stationary since 1895. Germany shows a rapid increase after 1885, which reached a maximum in 1912 just before the war; after the war her production suffered owing to Lorraine mines passing under the possession of France. France was a very bad third to England's second, but she came up to the second position after the great war, still she is very much behind Germany. The production of U. S. A. is greater than that of all European countries.

Germany was not slow to take advantage of this unique position, and under the concerted action of her rulers, industrial magnates, and scientific workers, she built up an industry which became a menace to the prosperity of the other industrial nations who were already in possession of the world markets. Her industrial organization came to be regarded as a model for efficiency, good management, and concerted action. The world had a test of this terrible efficiency in the World-War of 1914. The philosopher's Germany of 1860 was converted, as a result of systematic planning, in course of a few years, into a highly industrialized modern state that could throw gauntlet to all the other powers combined for world-supremacy.

For this transformation, the organization for scientific research available in the German universities and in the technical high schools was largely responsible. The cause for Germany's rise to predominance in scientific work is not far to seek. In German universities, the professor possesses the privilege of *Lehrfreiheit i.e.*, freedom for choosing the subject he has to teach. He is thus not much burdened with the usual routine work of teaching from text-books; because unlike his Indian colleagues, his duty does not consist in drilling raw students to qualify for degree examinations, but it consists in guiding advanced students in their research work. He can thus devote most of his time to original investigation of that particular science in which he has specialized, can call to his aid his assistants and fairly advanced students preparing for the doctorate degree, and utilize for his purpose the whole resources of his laboratory. The university student has not to cram text-books and prepare for degree examinations on fixed dates, but he carries on research work under the guidance of the professor, which would enable him to get a doctor's degree. He can thus choose his own subject of study, *i. e.* he possesses, as it is technically called, *Lernfreiheit* or freedom of learning. Under this admirable system the German universities and *Hochschlues* became active centres of research and were to a great extent responsible for the industrial efficiency of the country in recent years. It was at the university laboratories that A. von Baeyer carried out the synthesis of *aniline* dyes which was afterwards utilized by the *Badische Anilin und Soda Fabrik* for the manufacture of synthetic dyes.

In 1883, on the advice of the famous physicist, von Helmhotz, were established the various testing

laboratories after the model of the *Bureau des Standards et Mesures* of Paris. These include the *Physikalische Technische Reichsanstalt* (The Physico-Technical Federal Institution) with which is incorporated the *Reichsanstalt fur Mass and Gewicht* (Federal Institution for Weights and Measures). The object is defined as experimental advancement of exact physics and precision technic by scientific research work, and testing of measures and substances for all physical applications; this is a huge institution divided into a large number of sections, and containing a very large scientific staff. Here have been determined many important physical constants like the Stefan-Boltzmann radiation constant, Wien's constant, Planck's constant, the value of mechanical equivalent of heat etc. Besides this, there is *Chemische Technische Reichsanstalt* (Chemico-Technical Federal Institution), a *Biologische Reichsanstalt fur Land und Forst-Wirtschaft* (Biological Federal Institution for Land and Forest Management). The object of these institutions is to carry on testing and standarization of all kinds of meters, carry on research work for finding out important physical and chemical constants, and conduct other experiments of a national and international character. These institutions are fitted with resources and apparatus such as very few university laboratories possess, and often serve as the training ground for the would-be professors. They are mostly in charge of senior university professors who have retired from teaching work. In Germany, universities are also State institutions, and the co-operation between scientific services of the State and the universities is more intimate than elsewhere.

But still it was felt that the existing research organization was not sufficient for the country's needs. A man like Prof. F. Haber who had worked out, in his laboratory at the University of Karlsruhe, the synthesis of ammonia out of nitrogen from the purely scientific point of view would be much more useful to the nation if he were freed from the rather dull routine work of drilling the students for their doctorate, and were provided with a research institution, where large scale facilities and assistants were available and there was no routine teaching work, so that he could concentrate all his attention on the further work of the synthesis of ammonia. And so the process could be made a commercial success, and thus provide the world with a cheap method for the manufacture of ammonia and its derived products (ammonia, nitric acid), required for so many industries of great importance. Such were the considerations which prompted a number of German intellectuals to make a representation in 1911 to the then Emperor of Germany, Kaiser Wilhelm II, for founding more research institutions for advancement of science. The Emperor took up the cause with his characteristic energy and enthusiasm, and led the way to the foundation of the society now known after his name by heading the subscription list with a sumptuous amount from his own private purse. Naturally, the industrial magnates and business firms of Germany like the famous *Krupp* Works and *Badische Anilin und Soda Fabrik* followed suit, and in this way a large fund was raised, and the Kaiser Wilhem Society for the Advancement of Science came into existence in June 1911. The object of the organization is described thus by Dr. F. Glum, the General Director of the Society, "The Society's work is to supplement those done by universities, technical high schools, academies, libraries, and museums, and not to compete with them." This is sought to be achieved firstly by undertaking those studies which cannot be done in the above mentioned institutions, secondly, by providing research institutes for those gifted investigators whose time is too much taken up by the routine work of teaching and administration in universities and high schools, and thirdly, by providing places for those young academicians of promise who have taken their doctorates from the universities, but have not yet got any situation where they can develop their natural gifts and carry on further research work in their own lines.

In order that these ideals may be fulfilled it is necessary that the Society should keep an intelligent watch on the newer currents in scientific investigations and try to further its ideals by creating facilities for new lines of investigation and getting the right man for them. The object has thus been expressed by the President, Adolf V. Harnach, "The K. W. Society shall not first build an institute for research and then seek out the suitable man, but shall first pick up an outstanding man, and then build an institute for ,him." Experience has often shown that

it is rather useful not only to call an outstanding man to the headship of an institution, but also to group associated institutions at one place and under a loose federation. This should be the case for a very big science like biology, which can be satisfactorily advanced only if the various associated sub-groups work in co-operation for a long time. Therefore it is necessary to unite in one institute experts in different lines who are otherwise quite independent of one another. The directors of these institutes are, therefore, chosen from the ranks of experienced investigators who have retired or given up their teaching work in the universities, high schools, and other places, and the workers are to be chosen from such graduate doctors who have shown exceptional ability in a certain line of work. It has very often happened that after working for some time in the K. W. Institutes, they have qualified for professorships in the universities. In this way, the K. W. Institutes have served a very useful purpose in the educational and scientific life of Modern Germany.

The group of K. W. Institutes, so far in operation, include two types: one for carrying on pure researches on basic sciences like chemistry, physics, zoology, botany, and medicine; the other group for applying the knowledge of theoretical sciences like chemistry, physics, and biology, to applied sciences and to industry, and thereby making them useful to the economic life of the nation.

Besides 16 institutes of these types devoted to natural and physical sciences, there are four devoted to researches on German History and legal and cultural subjects. The work of the scientific institutes is reviewed in the Reports.

The administration is nominally entrusted to the general body of the members of the K. W. Society who are elected by the Senate from the ranks of outstanding scientists, business magnates, and other influential people, but it functions through a senate half of whose members are elected by the general body; the other half used to be nominated by the emperor, but now the power has passed to the Federal and the Prussian States. They are nominated from the directors and scientific members of the various K. W. Institutes, from the ranks of prominent scientists and representatives of political parties and of other economic interests. The Senate elects the Executive Body consisting of the president, vice-presidents, and other office bearers. The constitution thus ensures a close understanding and co-operation between the State, the industrialists, and the scientific workers.

The research institutes under the management of the K. W. Society thus form a unique feature of Germany's organization for scientific research, the like of which is not to be found in many other countries of the world.

Before the War the institutes under the Society were financed mostly by private benefactions and large advances from the different German industries. After the war, these sources of income became greatly limited, and the State intervened with large grants for keeping the institutes alive. Even now, though the private benefactions and industries are again coming forward to the help of the society, it has been found that without state help they cannot function.

Irrigation Problems in Bengal

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Introduction

Statement of the Problem

Lately the Irrigation Department of the Government of Bengal has come in for a good deal of criticism. The critics may be broadly divided into two classes. Some of them—and they probably constitute the vast majority—do not adequately appreciate the seriousness of the irrigation problems in Bengal. Having been favoured by nature with plenty of rainfall and abundant monsoon floods in most of the parts, Bengal, they argue, cannot have any serious irrigation problem to tackle. To this class of critics I can do no better than advise a perusal of the report of the Royal Commission on Agriculture in India (para 292), and that of the Irrigation Department Committee 1930, which was constituted in accordance with the recommendation made by that body. The major portion of Bengal is deltaic having been built up by the soil carried down by her rivers, and in some parts she is still being nourished by them. Even in the rest of Bengal there is no dearth of water resources, but the growing deterioration in health and prosperity of the province has to be traced to their faulty distribution. At some places more water flows than is necessary, frequently causing disastrous floods, and at other places decrease in flow through the natural waterways has caused serious deterioration, in many cases rendering them even incapable of draining the country side. Indeed, many of these streams which were originally intended by nature to spill over the land through which they traverse, and keep it in health and plenty by supplying the rich silt of the Ganges, the Damodar etc., have now been converted into stagnant pools of water, providing excellent breeding ground for mosquitoes, and many a district of Bengal, specially in the centre and in the west, has been rendered extremely unhealthy with steadily decreasing population and with land gradually going out of cultivation. Unless this faulty distribution of the available water resources, which has been effected partly due to the operation of natural causes and partly by human interference, can be rectified, a good portion of Bengal, in the words of the Irrigation Department Committee "will revert to swamps and jungles."

The other class of critics no doubt appreciate the seriousness of the problem, but their criticism is based mainly on the ground that very little is being done by the Department to tackle the problems, which are undoubtedly serious and there should not be any avoidable delay in their solution. My answer to these critics is that it is not possible to touch even the fringe of these problems without additional sources of revenue, as these works involve heavy capital outlay which it is impossible for the Government to finance out of ordinary revenues. The Government have however introduced in the Council the Bengal Development Bill with the object of financing these schemes, and if the bill becomes law a great opportunity will present itself to push through these development schemes. Without co-operation of the public, however, no progress is possible, and the first requirement in this respect is to create the necessary public opinion. The following article has, therefore, been written to acquaint the public with the irrigation problems in Bengal and, in very broad outlines, their solutions, so far as they have occurred to me in the light of the data that I have been able to study and the experience that I have gained in the discharge of my official duties.

Analysis of the Problem

The problems vary in different parts of Bengal. Thus in Western Bengal, specially in Bankura and Birbhum districts and in the western portions of Midnapore, Burdwan, and Murshidabad districts, the most pressing demand is for irrigation. Though in normal years the total rainfall may be considered to be more or less adequate, the distribution is erratic, and during the latter half of September and in October the rainfall is usually insufficient for the requirements of crops. In consequence, the outturn is usually poor even in normal years, and in years of scarcity which occur approximately once in 5 to 7 years, there is a total or partial failure of crops. The ryots can hardly afford to use any artificial manure, and the productivity of the soil is gradually decreasing. Canal irrigation can increase the productivity of the soil as the silt carried by the rivers in Western Bengal, particularly the Damodar, the More or Monrokshi, the Ajay, the Dwarakeshwar etc, is highly fertilizing. Thus a well-planned system of irrigation will enable the ryots to obtain in normal years adequate return for their hard labour in the fields by timely distribution of flood water suited to the requirement of crops as well as owing to the manurial value of silt deposited by canal water. In years of scarcity, it will help to ward off the famine conditions which would otherwise prevail in these parts.

Eastern part of West Bengal requires Flood flushing

In the eastern portion of Western Bengal also, irrigation would be useful; but the most pressing need is to improve its sanitary condition and to increase the productivity of the soil by means of flood flushing which the area has been deprived of as a result of embankments, and to restore the network of rivers within the area which, being deprived of the flushing from the parent streams, have badly deteriorated and can no longer serve as efficient drainage channels. The ideal solution would, no doubt, be to remove the embankments and to restore the natural condition prevailing before the embankments were erected. But owing to large vested interests such a solution is hardly practicable except in isolated areas. The next best solution would be to provide escapes at suitable places in these embankments,* improve the drainage channels, and flush the area during floods. This will be the most practical approach to natural conditions, and is likely to improve the sanitary condition as well as the productivity of the soil. The floods may not always occur when the crops require them, but the fertilizing value of silt and the improved drainage of the land would certainly increase the yield and improve the conditions of the peasants.

Northern part of Central Bengal requires Flood flushing

The problem in Central Bengal is more or less similar to that in the eastern section of Western Bengal, *i. e.*, flood flushing and improvement of drainage facilities are the most pressing needs. But unlike that area, the present situation has been created not so much by means of embankments as by nature. The most important of these natural causes is the diversion of the Ganges flood through the Padma channel. Being deprived of the Ganges spill, this area is not only rapidly deteriorating in respect of health but the productivity of the soil is also gradually decreasing. The network of spill channels which originally used to distribute the Ganges spill over this area and maintain its health and prosperity are now dead or dying. The most pressing need for this area is to improve these dying rivers and to restore the functions allotted to them by nature *viz.* to draw from the Ganges a portion of the floods now running to waste, distribute it over the land, thus improving its sanitary condition. and, after the silt, very rich in manure, has been deposited over the fields, and has increased its productivity, to drain the water ultimately into the sea.

* Embankments were in existence in this area even before British rule. But the ryots used to breach the embankments from time to time in order to let flood water into their fields. But when the railways were constructed and further embankments were made to protect the railway lines, it was by law made ***criminal*** to make any breach in the embankments. Thus the flood water was prevented to water the fields, and this led to the deterioration of sanitary conditions and the productivity of the soil. These embankments were, therefore, described by the late Sir William Wilcox, as satanic chains. Strong objection was taken to this remark by the Government and the Irrigation Department of Bengal at the time. It is now very refreshing to find that, after seven years, a responsible officer of the Department, and probably the Department itself, is of opinion that Wilcox was right and that the railway embankments have done incalculable harm to the Burdwan Division. —***Editor, S & C.***

Southern part of Central Bengal

The southern portion of Central Bengal *i. e.*, the area lying within tidal influence, has not yet deteriorated to this extent. The area is traversed by the lower reaches of these spill channels, and though, owing to the desertion by the Ganges flood, these channels can no longer continue their beneficient activity of flushing the area with silt-laden sweet water and raising the delta from above, similar work is being done by nature to a certain extent with the help of silt-laden water from the sea through the agency of the tides, except where man has interfered by prematurely reclaiming the land by means of embankments. In these latter areas, the position is gradually becoming more and more serious, as, not being allowed to spill, these channels are not only deteriorating by the deposition in their beds of silt carried with the tides, but the land too, which is well below high tide level and which should have been gradually raised by this silt, cannot rise. In consequence, difficulties of draining these lands are gradually becoming more and more acute. The solution is partly of a preventive nature *viz.* removal of existing embankments as far as practicable and the prevention of further embankments along tidal channels. But the real solution lies in the restoration of the Ganges spill referred to above, which, on its way to the sea through these channels, will flush them and maintain their efficiency by transporting back to the sea the silt which is now being deposited in their beds by the tides.

Eastern Bengal requires Conservation of the Waterways

In Eastern Bengal none of these problems have yet arisen, as the country is still being annually flushed by the silt-laden floods of the Ganges and the Jumna, and is being kept in health and prosperity. In the north-eastern portion of Eastern Bengal, for instance in Mymensingh District, drainage difficulties are no doubt being experienced owing to the diversion of the Brahmaputra flood through the Jumna Channel and consequent deterioration of the old Brahmaputra passing through the Mymensingh and Dacca districts ; but the situation is not so acute as that in Central Bengal. Just like the tidal portion of Central Bengal the Eastern Bengal possesses an important natural asset in the net-work of navigable channels ; and the most pressing need is to conserve and improve these natural waterways. Another problem of Eastern Bengal is that created by the rapidly eroding banks of her rivers. The problem is to a certain extent inherent in the conditions of flow of deltaic rivers, but it has been aggravated by the natural tendency to concentrate all available flow into the two principal rivers—the Ganges and the Jumna. Resuscitation of the rivers in Central and Northern Bengal, so as to enable them to carry their due share of flood water, will no doubt make the position somewhat easier but the erosion will still continue to remain a problem as the soil through which these rivers flow is extremely friable. Special study in a laboratory may perhaps reveal some cheap method of river conservancy by which this problem can be satisfactorily solved. But the method of direct action, *viz.* protection of the eroding bank by brick mattress that is now followed, is so very costly that it can hardly be used except for protection of important towns.

North Bengal needs Resuscitations of its dead Rivers

In Northern Bengal irrigation is necessary in the western portion but the most pressing need is the resuscitation of the moribund rivers which can no longer serve the country as efficient drainage channels, causing damage to crops by water logging and malaria. In this area the present situation has been created not by the acts of man, but by the diversion of the course of the Teesta river. Prior to the diversion of the Teesta to its present course along the north-eastern extremity of this area in 1787, the water, at present carried by it, used to be distributed through the Attrai, Jumna, Karatoya, and Punarbhaba, and thus the health and prosperity of North Bengal was maintained. Deprived of the flood water from the Himalayas which is now carried by the Teesta into the Brahmaputra, these rivers of Northern Bengal are dying and are unable to function efficiently even as drainage channels. The most pressing problem in Northern Bengal is to resuscitate these dying rivers so that they can at least serve as efficient drainage channels. *(To be continued.)*

Classification and Significance of the Symbols on the Silver Punch-marked Coins of Ancient India—A Review

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The oldest indigenous coins of India are known as the punch-marked coins from the system of manufacture employed; the symbols were punched on them. The silver ones were denominated the Dharanas or Purānas of 32 ratis, approximately 56 grains in weight; while the copper coins were called the Karshapanas of 80 ratis or 146 grains. These coins were in circulation in this country from the earliest times when the coins were invented to the 1st century A. D. in Northern India, and 300 A. D. in the South; and most probably the copper punch-marked coins preceded the silver ones. The coin-denominations in the 4th century B. C. from Kautilya's Arthashastra were the Pana (an abbreviation of Karshapana, which later on became a generic expression for coins), half, quarter, and one-eighth, as silver coins, and Mashaka, half-Mashaka, and Kakani as copper ones. The punch-marked coins in thousands have been found in "almost every ancient site in India from the Sundarbans in Bengal to Kabul and as far south as Coimbatore." These flat pieces of metal, silver or copper, were generally covered with symbols which were impressed on them by separate punches. The importance of these coins to the historians of India had been fully recognized by Vincent Smith; they are "the authoritative records of the symbolism-religions, mythological and astronomical current throughout India for many centuries."

Cunningham was the first to establish the indigenous origin of the punch-marked coins, and he handled a large number of them; but it was Mr. W. Theobald who made a systematic attempt to describe and interpret the symbols on these coins. He dealt with about 300 symbols and classified them rather arbitrarily into six sections— "they comprise human figures, arms, trees, birds, animals, symbols of Buddhist worship, solar and planetary signs." He did not classify them as pointed out by Mr. Durga Prashad "according to their symbol-groups, fabric and weight, which is the clue to differentiate one type from another." While trying to arrive at the significance of these symbols, Theobald discovered that some of the symbols found in the punch-marked coins of India were similar to the ancient symbols found in the early stones of Europe. The next scholar who seriously grappled with the problem was Mr. Walsh who elaborately described the two hoards of silver punch-marked coins found in Patna and Ghoro-Ghat in the Bhagalpur district of Bihar. Mr. Durga Prashad has now taken up the study of these coins in right earnest, and the results of his extremely painstaking labours based on the personal examination of about 400 such coins are incorporated in the recent Journal of the Asiatic Society of Bengal (No.3,1934), Numismatic Supplement No. XLV. In his paper Mr. Durga Prashad deals with the classification and significance of the symbols on the silver punch-marked coins of Ancient India. "Attempt has been made to revise the list of symbols found on the silver punch-marked coins illustrated and described by Mr. W. Theobald in J. A. S. B., Vol. LIX, 1890, and Vol. LXX of 1901, by carefully copying the figures from well preserved coins, for the sake of accurate and scientific classification of the coins according to the symbol-groups punched on them, which would be actually helpful in differentiating the various types of different periods and localities, thus providing a key to ascertain the period in which they were minted for currency." He has illustrated 564 figures, some of them being

really variations of the same symbols with about half a dozen doubtful ones and treats of six different types of coins. The correct interpretation of the sombols as pointed out by Mr. Durga Prashad will surely, "open a new vista for researches in the history of ancient India", and the most important discovery assuredly is the resemblances of some of these symbols "to the figures and the pictographs found on the Mohenjodaro seals"—34 are exactly similar and the other 8 have close resemblance. It is therefore evident that some of the symbols date from the Chalcolithic period, and their diffusion in other countries on the early stones of Europe, would lead us to conclude that some of them may be as early as the Neolithic Age, if not earlier, when symbols played a far more important part in human life than being the usual vehicle of expressing human ideas. Whether the import of some of these early symbols would ever be divulged to us is a doubtful question and it is to anthropology and early history of man that we shall have to turn to unravel the riddle. At least it is sure that these symbols stood for certain ideas- -which were easily understandable by early men—and when they migrated and separated from one other, they took the symbols with them no doubt, and their significance was clear to them. But as men progressed and life became more and more complex, the earlier significance was sometimes lost or clouded by newer ideas, or later interpretation was fastened on them. We in the 20th Century, fail to appreciate the importance of symbolism in the early history of man, and if we had the clue to unravel the mystery, human life in its childhood would stand revealed before us. But we must differentiate between the symbols—some are common human heritage, while some were adopted through mere caprice by a particular ruler, a distinct locality, or perhaps a different mint. Historically all are important to us, and if we could know which particular symbol or group of symbols came to be adopted by a dynasty of rulers, a particular king, locality, mint, or a guild of merchants, our knowledge of early history would be more complete and the identification of the coins a mere matter of patient research. Mr. Durga Prashad, by his scholarly researches and his extremely illuminating plates, has laid us under a heavy debt. He has not only given us a presentation of the most difficult problem confronting the Indian numismatists, but has made it possible for other scholars to study the subject with the help of the numerous illustrations appended to his paper.

Mr. Durga Prashad has divided the punch-marked coins into 3 sections in chronological order—the Early, the Middle, and the Later or Mauryan period, coins. The early coins "have a very archaic appearance" and of a lighter standard of weight of 24 raktikas. There are certain difficulties in the way of the acceptance of this identification. The weight of 24 ratis is mentioned in later works and not in Manu; and the designation, Purana or the '*Old*', given to the punch-marked coins is not confined to the early coins, but also to the coins of that time and later. Moreover, the word might be explained with reference to the method of manufacture. The punch-marked coins came to be gradually supplanted, at first only partially by cast or die-struck coins, and the earliest cast coins can be ascribed to the 5th century B. C. at the latest; it is but reasonable to infer that the coins manufactured in the *old* way by punching as distinguished from cast and die-struck coins were denominated the Puranas, the '*old*', as compared with the newer coins cast in mould or die-struck. Numismatists are generally of opinion that the earlier punchmarked coins had usually blank reverse, or only "one, sometimes two or more, minute punch marks;" while these coins have 3 to 14 symbols on the reverse side. We have also to remember as pointed out by Prof. Rapson that the Indian coin-types were "essentially local in character" and the archaic appearance of the coins under review might be ascribed to the peculiar conditions of the locality issuing them; we find on occasions that even when a better system comes in vogue, the older system is given the preference, *e. g.* among the Indo-Sassanians. The complete acceptance of the classification proposed requires further elucidation.

In the description of the 407 symbols Mr. Durga Prashad has been very successful and leaves very little to be desired; when he comes to their interpretation, "he is well aware of the soft ground he is treading," as he has himself put it. Complete success in this matter is out of the question, as some of the symbols, as previously pointed out, belong to the

earliest period of human culture. Mr. Durga Prashad relies for their interpretation on certain *Tantric* and other texts which are hundreds of years later than the punch-marked coins. We cannot, however, on that score reject the interpretation based on these late texts altogether, because they may contain genuine traditions of olden times about these early symbols. There is, however, a great risk to be guarded against: the symbols which were the common heritage of the different religious sects of this country might have been adopted by the later writers and a new interpretation put on them; just as the *Swastika*, one of the oldest symbols, has been recently adopted by the Nazis of Germany. But there can be generally no objection to the acceptance of the nomenclature for these symbols taken from the *Tantrik* texts as these are mainly of a descriptive nature. So the correct attitude seems to be to suspend judgment and to await further and fuller discussions. These symbols were the ankas or heraldic devices of the different rulers, mints, or localities, and some of them might have been adopted arbitrarily, merely as a matter of caprice, and to search for their significance would be in vain. It has now been definitely proved that the punch-marked coins are "a public coinage issued by authority", and consequently these are assignable to a particular state, ruler, or locality, if we only have a key to the identification of the different symbols and their combinations employed in the coins. The same symbol may be found with modifications (*e. g.* Symbols 1-11, Pl. XXII; 2-28, Pl. XXVI.) and the variations might be due to their employment by the different rulers or, in some cases, by the same ruler in different localities or mints. However, it is an intriguing subject and much work has not been done in this direction. Mr Durga Prashad takes the Hill symbol (*Meru*) surmounted by the crescent to be the emblem of Chandragupta Maurya. This symbol was found by Dr. Spooner on a stone pillar at Kumrahar (Patna) which is generally ascribed to Chandragupta; so *some* of the coins bearing this symbol might belong to the Maurya Emperor Chandragupta. We might have a surer footing, if we could ascertain the group of symbols usually 5 in number of which the *Meru* or the Hill symbol was one. The suggestion that this symbol is the monogram of Chandragupta Maurya cannot be accepted as it is difficult to conceive of the use of an ideograph—the crescent for 'Chandra', the moon, with the phonetic figures, the three arches, if they really read "Gupta". Another symbol (Pl. XXVI, 2-28), a *chakra*, composed of three arrows and a central circle with a big dot, designated *Shadara-chakra* by Mr. Durga Prashad has been assigned to the Maurya period. I would rather prefer Mr. Walsh's identification of it to three umbrellas bound together in the middle, as we know that umbrellas are specially associated with the majesty of the State in Hindu India and it might be "the mark of the supreme government." The figure 21 (Pl. XXII) which is "found on 99% of later coins" is assuredly not the sun, but it may be the 'discus', the special emblem of the rulers justifying their title of Rajachakravartty "the king who is the wielder of the discus". It may be that these two symbols of the Three-Umbrellas and the Discus were the special emblems of the dynasties claiming imperial power in ancient India. The variations of these two symbols which are found in all the coins of plates 1,5 and 9 to 21, and the other accompanying symbols forming groups of five, have not been explained except that the *Meru* or Hill symbol which is the third in coins Nos. 93-131 (Pl. XVII-XIX) belongs to Chandragupta and a Hill of five arches with a peacock perched on it (Fig. 36 Pl. XXVI) has been ascribed to Asoka. Similarly, it might be possible to identify other coins as a result of careful study, though absolute certainty as regards identification is well-nigh impossible under the present state of our knowledge. The *Swastika* (Fig. 105 -Pl. XXIII) is not only a very ancient symbol but also well known. It is found practically all over the world and the Hindus deem it specially auspicious. How it originated, it is difficult to determine, but scholars like Havell and others think that it represents the visible movement of the sun round the earth to which we owe the seasons and the consequent productivity of the soil, and hence all our prosperity and happiness. This rotatory movement was at first expressed by symbols like Nos. 84, 97 (Pl. XXIII), and a stereotyped form was given to it with its four hands turning to the right. It is auspicious and its opposite *i. e.* hands turning to the left is now looked upon as inauspicious and consequently not used in modern times. Figs. 110-116 (Pl. XXIII) are taken by the author to be variations

of the symbol of the eye. Similar symbols we have on the seals of Mohenjodaro and Harappa, and knowing full well the prevalence of the cult of the Toni and the Lingam in the Chalcolithic period of which various specimens have been found in the ancient sites, we would rather prefer to identify these symbols (Figs. 110-116) with Toni and the fig. 120 with the Lingam, the symbolic representation of the creative energy. Another identification with which I cannot agree is that of the symbols 1-11 (Pl. XXII), the so-called "Taurine". Mr. Durga Prashad takes it to be the Brahmi letter 'Ma'. But in all the symbols dealt with, not a single other letter has been identified; and it throws the author in a difficult position; for example, when discussing Fig. 38 (Pl. XXVI) he writes, "the puzzle is to explain the presence of M's". This so-called 'Taurine' or 'Ma' is perhaps "a simpler form" of the Nandipada symbol as pointed out by Prof. Rapson. The name of the symbol we get from an inscription in the Padana Hill and it was used by all the sects of Ancient India, the Hindus, the Buddhists, and the Jainas, and are found not only in coins but also in sculptures. As the review is already a long one, I have to bring the discussion to an abrupt close.

Mr. Durga Prashad's enthusiasm for the subject of his choice is unbounded, and by his patient labours he has earned the gratitude of the Indian numismatists, and it is ardently hoped that he will give us more about this enchanting subject in future.*

*Mr. Durga Prashad's contribution to the Journal of the Asiatic Society of Bengal—Num. Sup. No. XLV.

Snake Venom

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Poisonous Snakes and Extraction of their Venom

The poisonous snakes have been divided into two great families, the colubridae and the viperidae. Without entering into further details of classification, it may be stated that the cobra and Russell's viper (Daboa) may be considered as typical representatives of the colubridae and the viperidae families respectively. In India, the largest number of deaths by snake bites is caused by the cobra and next to it by Russell's viper. The poisonous snakes contain two powerful fangs, one on each side of the upper jaw. Each fang is traversed by a canal, one end of which communicates with the poison glands, and the other end opens near the tip of the tooth (on the convex side). The venom is secreted by these glands and the fangs are used by the snake as inoculating apparatus. Venom can be extracted from the poison glands of either freshly killed or living snakes. The living snake is held tightly by the neck so that it cannot turn its head. The edge of a small dish covered with thin guttaparcha membrane is then introduced between its jaws and the poison glands are pressed gently. The venom collects in the dish. It is needless to add that it requires good technical skill and coolness to extract venom from big and powerful snakes. Freshly collected venom is a syrupy liquid with yellowish tinge, and shows a weak acidic re-action with litmus. When dried, it becomes translucent and cracks into small lamellae like dried egg albumen. Venom, whether fresh or dried, is soluble in water.

Physiological Action

The effects produced by venom depend on the species of the animal bitten, on the species of the snake inflicting the bite, and also on the site and the severity of the bite. Thus the bite of a colubridae produces practically no effect (local), while that of a viperidae produces severe local effects. On the other hand, the general intoxication is much more pronounced with the venom of colubridae than with that of viperidae.

The effects produced in cases of fatal bites inflicted by a colubridae or a viperidae may be described as follows: When a person is bitten by a snake of the colubridae family, say cobra, the victim does not feel much pain in the region of bite, although a numbness supervenes in that part and spreads rapidly throughout the system. The patient soon experiences a kind of lassitude and an almost irresistable desire for sleep. He can scarcely support himself on his legs, and feels difficulty in breathing. A drowsiness gradually overcomes the patient. The difficulty of breathing becomes greater and the pulse becomes slower and weaker. The eyelids droop, the tongue is swollen, and there is profuse secretion of saliva. After a few hiccups the patient falls into the most profound coma and dies. In some cases, even after respiration has ceased, the heart continues to beat for nearly two hours. All this happens in the course of two to seven hours, rarely more.

At the autopsy, the blood is found to remain fluid. Small haemorrhagic patches are noticed on the surface of the liver, spleen, and other tissues. Small infarcts scattered all over the lungs are also noticeable.

If the bite is inflicted by a snake of the viperidae family, the victim feels acute pain in the seat of bite which soon appears red and then, purple. Sharp pain accompanied by cramps extends towards the base of the limb. The patient feels extreme dryness of the mouth and throat and intense thirst, In a few hours he becomes insensible and exhibits difficulty in breathing. Asphyxia then ensues, and the respiratory movement ceases. The heart, however, continues to beat for about a quarter of an hour after respiratory movement has ceased completely.

At the autopsy, the blood, instead of remaining fluid, is found to clot into a mass in almost all

the vessels. Six to eight hours after death, the clots begin to redissolve, and then become fluid as in poisoning by cobra venom, Enormous dilatation of the capillaries in the abdominal organs and extensive haemorrhage in the serous cavities are also noticed.

Approximate lethal Dose for Man

It is difficult to estimate accurately the lethal dose of a venom for man. Assuming, however, that the resistance of human beings is intermediate between two higher species of animals, approximate figures have been worked out for venoms of different snakes. These are recorded in Table I along with the maximum quantity of venom which these snakes can inject. It may be mentioned, however, that the toxicity of the venom may be greatly modified by the route by which it is administered. Thus a dose of cobra venom which proves fatal to rats on subcutaneous injection produces no harmful effects when administered by mouth. Even two or three times the lethal dose does not cause any harm. This is not the case, however, with viper venom. It can produce fatal effects even when administered through the mouth.

TABLE I

Snake		Maximum dose given at a bite in m. gm.	M.L.D. for man in m. gm.
1. Naja Tripudians (Cobra-de-Capello)	..	211·0	15·0
2. Naja Bungarus (King Cobra)	..	100·0	12·0
3. B. Candidus (Common Krait)	..	5·4	1·0
4. V. Russelli (Daboa)	..	72·0	42·0
5. E. Corinatus	..	12·3	5·0
6. L. Gramineus (Green pit Viper)	..	14·1	100·0

It will be noticed from the above table that a king cobra can inject at a single bite many times the dose lethal for men. Elephants bitten by the cobra have been reported to have died within three hours of the bite. It is, however, fortunate that seldom a snake gets opportunity to inject the maximum dose in a single bite. The average dose of venom injected in a bite is, therefore, much smaller than the figures given above.

The Complex Nature of Venom

The snake venom is a mixture, consisting of leucocytes, mucous, epithelial debris, nitrogenous and non-nitrogenous organic compounds and salts (mostly chlorides and phosphates of calcium, magnesium, sodium, and ammonium). The toxic constituents of the venom are usually believed to be nitrogenous organic compounds, resembling the proteins in many of their properties. Some of the important constituents are (*a*) the neurotoxin, (*b*) the haemolysin, (*c*) the haemorrhagin, (*d*) a blood coagulating principle, and (*e*) one or more proteolytic enzymes.

(a) The Neurotoxin:

This is the most active poison in the venom of the colubridae family. When an animal is bitten by a reptile of this family, death is caused mainly by the neurotoxin. This toxin is not destroyed by heating its solution at 75°C for about 30 minutes, or at 100°C for a short time. At 120°C, however, it is destroyed rapidly. It strongly affects the nervous system. In the first instance it brings about a suppression of the functions vested in the nerve cells that are found in connection with the vagus nerve, the spinal accessory, and the hypoglossal. Later on, the excitability of the nerve endings in the muscles is found to have been destroyed. This action shows great similarity to that of curari. The nerve cells have a strong affinity for the neurotoxin. When shaken with brain emulsion, the toxin is almost completely removed from its solution and fixed by the brain matter. It may be mentioned that the venom of some viperidae is also rich in neurotoxin.

(b) The Haemolysin

The venom of almost all poisonous snakes can produce haemolysis of the red blood corpuscles of animals. This haemolytic power is attributed to a toxic principle called haemolysin. In vitro-experiments it has been observed that if the red blood corpuscles, say of horse, are carefully washed with physiological saline (0.8% NaCl solution) venom by itself cannot haemolyze them. An addition of normal horse serum preferably heated, or of a few drops of dilute lecithin solution, restores the haemolytic power. It has been suggested that haemolysin combines with lecithin and it is this com-

plex lecithide which brings about the haemolysis of the red blood corpuscles. The activating action of the heated normal horse serum has also been traced to the presence of free lecithin in it. Like the neurotoxin, the haemolysin is also resistant to heat and is not destroyed if its solution is heated at 100°C for a short time. Heating at 120°C however rapidly destroys the haemolysin. It has been separated from the neurotoxin by taking advantage of its combination with lecithin to form a complex compound.

(c) *The Haemorrhagin*

It has already been stated that a viper bite often produces a severe local reaction. This is caused by a toxic substance which has been termed haemorrhagin by Flexeur and Noguchi. The haemorrhagin is destroyed when a solution of viper venom is heated at 75°C. Thus, it has been observed that 0·5 milligrams of crotalus (viperidae) venom, heated previously at 75°C for thirty minutes, fails to kill a guinea-pig on intracerebral injection while one tenth of this dose of fresh venom is sufficient to kill a guinea-pig of the same weight, death being due to severe haemorrhagic lesions in the brain. The haemorrhagin is, therefore, less thermostable than the neurotoxin or the haemolysin.

(d) *The Blood Coagulating Principle*

It has already been mentioned that postmortem examination of victims of viperidae bite reveals in addition to other changes coagulation of blood in all the vessels, provided death occurred shortly after the bite. In vitro-experiments, however, it has been found that while in weak doses the venom always coagulated, citrated, or oxalated, blood, in strong doses it fails to produce such effects. This phenomenon was investigated by Calmette and Noe and the cause was traced by them to the presence of proteolytic enzymes in the venom. With strong doses of venom, the fibrinogen and other proteins in the blood were digested by the enzymes and thus clotting was prevented. When a solution af viper venom is heated at 70°C for sometime, this blood coagulating principle is destroyed.

(e) *The Proteolytic Enxymes*

The dissolving action of snake venom on the endothelium of the blood vessels and on the muscular tissues was recorded by many early observers. Its action on proteins, like gelatin, fibrin, and egg-albumen. was first investigated by Flexeur and Noguchi. Venoms of viperidae as also those of colubridae can digest fibrin, gelatin, and fresh egg-albumen. Gelatin solution, thus acted upon, loses its power of setting to a jelly. The disintegration of caesin and serum albumen solutions by venom does not proceed so far as to the peptone but stops at the albumose stage. It has been noted that neither snake venom nor pancreatic juice alone can digest coagulated egg-albumen. A mixture of the two, however, can readily dissolve the coagulated albumen. A solution of venom loses practically all its proteolytic power when heated at 70°C for sometime. Snake venom can also bring about the lysis of some bacteria and protozoa. It is not known whether this lytic action is due to the presence of specific lysins or to that of the proteolytic enzymes in the venom. It may be mentioned that none of the constituents discussed above have been separated in a sufficiently pure state for the study of their chemical and physico-chemical properties.

When a solution of snake venom is exposed to light, its toxic properties are either modified or completely destroyed, depending on the intensity of the source of light and the period of exposure. Oxidizing reagents like potassium permanganate, potassium dichromate, ozone, chlorine, bromine, bleaching powder, hypochlorites etc., destroy the toxicity of the solutions of snake venom. Calcium chloride can also attenuate venom.

Treatment of Snake Bite

Since solutions of permanganate and hypochlorite destroy the toxicity of venom, percoalation of the site of the wound with solutions of these substances immediately after the bite, has been recommended by many. The most scientific treatment, however, is the intravenous injection of the proper antivenomous serum in appropriate dose (such antivenin serum was first prepared by Calmette). Polyvalent antivenomous serum is now being produced in the various serum institutes. In India, antivenomous serum which can cure cases of cobra bite of moderate severity as well as of Russell's viper bite is manufactured at the Central Research Institute at Kasauli.

The Kaiser Wilhelm Society

The Twenty-Fourth Annual Report of the Kaiser Wilhelm Society for Advancement of Science, (April 1934 to March 31, 1935.)

The Society shows a total membership of 656 against 693 on April 1, 1934. This records less of 37 against 93 of the previous year. Of these 11 died, and 65 discontinued their membership (probably these were Jewish scholars expelled from Germany by the Nazi Government), and there are 10 new entrants. The present president is Prof. Max Planck, the celebrated author of the Quantum Theory of Light, who succeeded the first president and the spiritual founder of the Society, Dr. Adolf von Harnack, who died in 1931. One of the vice-presidents is Dr. F. Krupp von Bohlen and Halbach, the present head of the famous Krupp Iron Works. The Society is now supported mainly by the State as, owing to the bad financial condition of the different industries, the income from these sources has been greatly reduced.

Amongst the new additions is to be mentioned the K. W. I.* for Physics at Berlin-Dahlem, originally planned for Prof. Einstein of Relativity fame. The building of the Institute was started with funds supplied by the Rockefeller Foundation, and has been completed at the expense of the State. Dr. P. Debye, at present Professor of Experimental Physics at the Leipzig University has accepted the invitation of the Society to act as director of the Institute.

A large number of lectures were held at the Harnack-house, Berlin, by the scientific members, directors of the various K. W. institutes, and foreign *savants*. The following is a brief account of the activities of the research institutes under the control of the Society.

The K.W.I. for Researches in Water Power and Hydraulics, Munich

This Institute specializes in all kinds of problems connected with flow of water through rivers and canals. In fact, this is a River Physics Laboratory During the current year this laboratory received an interesting order from the National Chinese Government of Nankin for experimenting with laboratory models for the regulation of water through the river Hoang-Ho in Northern China. It may be remembered that the daily press reported some weeks ago that the Hoang-Ho (The Yellow River) had burst its embankments and caused a severe flood in which a million people are said to have been rendered homeless, and about a hundred thousand perished. The catastrophic floods of the Yellow River are not casual events, but are periodic occurrences which have occurred through ages, and have been matters of grave anxiety for the rulers of China. These floods have caused such enormous damage to men and crops that the Hoang-Ho is known as *China's River of Sorrows*. The National Government has engaged the services of German and American experts to find out whether training work is possible whereby the danger caused by such floods can be minimized. The laboratory work is conducted by Dr. Engels of Dresden in a model channel, 120 metres long, and 9 metres broad, in the experimental station at Obernach, and water under high pressure is driven through the channel for finding out the ideal form of the bed and for studying the effects of deepening and straightening of the channel. The results obtained from such studies will be presented to the Chinese Government in the form of a report, and utilized in the planning of the future training works for this river. The SCIENCE and CULTURE from the very beginning has been pleading for the establishment of a River Physics Laboratory for Bengal, for the fate of no country, not even that of China, depends so much on rivers at that of Bengal. It is hoped that in all future engineering undertakings such as canals, railways, and bridges, which are likely to disturb the natural flow of water through her rivers, the Bengal Government may take a lesson

* K. W. I. denotes Kaiser Wilhelm Institute.

from the Chinese, and should sanction no plan unless it has been tested in a River Physics Laboratory by means of laboratory models.

The K. W. I. for Investigation of Metals, Stuttgart

It is a new institute which has been built in the centre of Germany's industry with the aid of funds provided jointly by the State of Wütermberg, the City of Stuttgart, and the Union of German Metal Industries. It has planned a large number of research works on metals and their alloys, and on the X-ray tests of metal works and their physico-chemical properties.

The K. W. I. for the investigation of Iron, Dusselldorf

This institute is situated in the centre of Germany's Iron Industry. Iron and steel have been described as the backbone of modern civilization, and every year demands for new kinds of steel for different purposes are increasing. The present institute is considered as one of the most important for national welfare, and is under the direct patronage of the federal state and the great Krupp Works, whose present head is, as mentioned before, one of the vice-presidents of the K. W. Society. This institute appears to enjoy a sumptuous grant as it contains a very large number of workers and is fitted with the most up-to-date apparatus. It carries on investigations on the metallurgical processes for the manufacture of different kinds of steel, their chemical, physical, and mechanical properties.

The K. W. I. for investigation on Coal, Mulheim, Ruhr

This institute is situated in the Ruhr district, famous for its coal deposits. The most outstanding contribution of this department has been the working out of a practical method for synthesis of Benzene from coal by the director Dr. F. Fisher and Dr. Tropsch. A big chemical firm in Germany (the Ruhr Chemical Works Ltd.) has built up an experimental factory for working out the process industrially. It is necessary to explain to the Indian readers why this process is considered to be of such vast importance for Germany. Though Germany has plenty of coal deposits, she has got no oil, and in case a war breaks out, most of her automobile traffic would be seriously handicapped. Though technical processes for conversion of brown coal to oil has been discovered (the Bergins Process), such oil cannot compete with natural oil on account of the high cost of manufacture. The present discovery is expected to bring the economic solution of the problem within the range of possibility. The Institute has got before it various connected problems still to solve, namely, the perfection of synthesis in different stages, the solution of the problem of regeneration of contact catalysers which are used for the *hydrogenation of coal*, utilization of the different products of synthesis (Benzene, oil, and Paraffin), and the question of their application and of further conversion to lubricating oil and other chemical products. The Institute has been able to work out the synthesis of different kinds of lubricating oil and of heavy oil used in Diesel Motors. Many other interesting works in this connection are being carried on in this institute for which reference may be made to the original report.

The K. W. I. for investigation of Silicates, Berlin-Dahlem

These laboratories are devoted to the investigation of all kinds of silicates which include, cement, mortar, bitumen porcelain (ceramics) and glass.

The director of the Institute, Prof. W. Eitel, is a physical chemist and mineralogist of eminence. Important research work for the improvement of glass and ceramic industry is being carried on in this institute. Attempts are being made in these laboratories to synthesize precious minerals under high pressure and temperature on the same lines as in the Geophysical Laboratory at Washington, U. S. A. It is at present investigating the problem of coloration of glass, particular attention being paid to various lead glasses.

The K. W. I. for Leather Research, Dresden

The director of this institute, Dr. W. Grassmann, is a distinguished authority on the chemistry of leather. The Institute is trying to develop the scientific side of the tanning and agricultural industries of Germany. The analysis and synthesis of proteins and the action of proteolytic ferments on proteins and polypeptides are being investigated.

The K. W. I. for investigations of fluid motion with which is incorporated the State-owned experimental station for Aerodynamics (Goettingen, Germany)

This Institute is under Prof. Prandtl, a famous authority on fluid motions and a professor in the University of Göttingen, and the sub-section on experimental aerodynamics is under Dr. Betz.

This laboratory specializes in all kinds of fluid motion, theoretical as well as experimental. It contains a big wind tunnel through which wind at any velocity can be sucked, and models of aeroplanes can be tested for stability, the best form of wing and other problems connected with aeroplane flight being always under investigation. It, therefore, serves as a testing laboratory for all kinds of aeroplanes, as well as a research laboratory for new inventions in aeroplane flight.

The present year's work consists of some theoretical work on the influence of turbulent motion on the earth's atmosphere in the lowermost levels, study on the influence of profile forms of aeroplane wings on distribution of pressure, total resistance to aeroplane flight, mechanics of atmospheric circulation etc.

The Society has under its control the following institutes for the investigation of problems of pure science.

The K. W. I. for Radioactivity at Berlin-Dahlem

This is Germany's foremost institute for investigation of problems connected with radioactivity.

It is divided into two sections, one under Dr. Hahn, dealing with chemical problems, and the other under Dr. (Miss) Lise Meitner, dealing with physical problems. It is not possible for every laboratory to undertake researches on radioactivity as was emphasized by Prof. D. M. Bose in his letter to the August Number of SCIENCE AND CULTURE, for such work requires supply of a good quantity of radium, costing a large amount of money.

In 1911 when K. W. Society was founded, one of the reasons given for the foundation of such an institution was that Germany at that time was rather backward in investigations on radioactivity, for while France had her Madam Curie, and England a flourishing school of research in radioactivity which owed its existence mainly to the energy of Lord Rutherford and his school, no outstanding contribution on this subject had yet come from Germany. It was attributed to lack of facilities for research in these lines in the university laboratories in Germany. Since then the K. W. I. for radioactive researches has more than made up for the past backwardness of Germany, and its workers have made very notable contributions to the subject. These include discovery of radiothorium, mesothorium, (a cheap substitute for radium), protactinium of which the Institution has got a supply of 500 milligrams, the largest in the world.

The physical section under Dr. Meitner has made outstanding contributions to problems of α- and β-ray disintegration. The present year's activities included investigation on Nuclear Physics particularly on production of Induced Radioactivity by bombardment of atoms with neutrons. The laboratory reports that it is able to produce elements of higher atomic number than uranium by neutron bombardment, a discovery first claimed by the Italian professor, Fermi, but not since confirmed.

The K. W. I. for Electro-chemistry and Physical Chemistry, Berlin Dahlem

There is no report from this institute which up to 1933, was under the directorship of the celebrated Dr. Haber. As mentioned above, Haber was the man who first worked out a cheap method for the synthesis of ammonia out of nitrogen of the atmosphere just before the outbreak of the Great War.

It is said that but for this discovery the war would have been finished within six months, as the Allied Powers placed an embargo on the import of Chile saltpetre which is the raw material for the manufacture of all kinds of explosives. Haber's discovery made Germany completely independent of any outside supply in the matter of manufacture of explosives. After the war the process has been still further developed and widely applied for the manufacture of fertilizers and other chemicals. The Laboratory had a sub-section for investigation of

colloid chemistry under Freundlich. After the War it undertook a large number of investigations of fundamental importance such as gas reactions, ionization potential of elements (Franck, theories of catalysis, investigation of spectra of atoms. For a time, it is reported, Haber was engaged in working out a practical method for recovery of gold out of sea water in certain parts of oceans which, on geological grounds, are known to be rich in gold. He is said to have undertaken a journey for this purpose to the Chile coast, but the effort does not appear to have been successful.

The Institute was closed in 1933 by the orders of the Nazi Government as the Director and a number of prominent workers happened to be of Jewish descent. Many of the workers found asylum in England and America, and Haber himself got an invitation to settle at Cambridge. But he died while on his way to a health station in Switzerland. About this sad incident wrote Dr. Von Laue, the discoverer of the physical nature of X-rays --"Themistocles is known to history as the victor of Salamis and not as a refugee in the court of the Persian Emperor." *

The K. W. I. for Biology, Berlin-Dahlem

This is divided into three sections, presided over respectively by Dr. Wettstein, Goldschmidt and Hartmann. This institute specializes in the inquiry of the questions of fundamental biological importance, as for example, those of genetics, mutation theory, mechanism of absorption of salts by plants and animals, investigation on chromosome morphology of Drosophila, and its genetic significance, cases of haploid parthenogenesis etc. On account of excellent facilities for research provided in this institute, it attracts a large number of foreign scholars of note and standing.

* Themistocles was the Athenian patriot who organized the Greeks for defence of their country against the Persians who attacked Greece in 485 B-C. under the leadership of their Emperor, Xerxes, and he was responsible for the naval victory at Salamis which produced the turn in affairs leading to the final expulsion of the Persians from the Greek soil. By a strange turn of fortune, the very same Themistocles was expelled by a political faction hostile to him from Athens and he ended his days as a refugee in the court of the Persian Emperor.

The K. W. I. for Bio-chemistry, Berlin-Dahlem

This institute on Bio-chemistry with a section on Immuno-Chemistry and tobacco research under the direction of Prof. C. Neuberg is also world famous. Prof. Neuberg like Prof. Haber helped Germany considerably during the War by his researches. There was a great shortage of animal fat in Germany, and hence very little glycerine could be prepared during the War. Without glycerine, nitro-glycerine which when mixed with *kieselguhr* forms dynamite cannot be produced, and hence Germany ran the risk of being short of explosives during the War. The Director of the Institute in his researches on fermentation noted that small amounts of glycerine is produced even in the alcoholic fermentation of glucose according to the following equation :--

$$C_6H_{12}O_6 = CH_3CHO + CO_2 + C_3H_8O_3 \text{ (glycerol)}$$

The acetaldehyde was made to combine with sodium sulphite, and hence the formation of glycerine from sugar was facilitated. Based on this method large amounts of glycerine were manufactured in Germany during the Great War. This research was considered to be of great importance by the Nobel Committee in Sweden and Prof. Neuberg was awarded a Nobel Prize in Chemistry in 1931.

The K. W. I. for Cell Physiology, Berlin-Dahlem

This institute is presided over by Prof. O. Warburg, a Nobel Laureate. Recently a highly equipped laboratory has been built for him with special grant from the Rochefeller funds. There are always several foreign professors working in this laboratory, as excellent facilities for research work are available here. Prof. Warburg's researches on the energy relations of carbon assimilation and the mechanisms of cell respiration are widely known. During the last few years he has been busy with important investigations on the respiration of cells suffering from cancer. These researches which are of very great importance in understanding the etiology of this dreadful scourge of humanity have been incorporated in the form of a book which has been now translated into English. During the last 3 to 4 years he has published important results on oxidation enzymes. These oxidation enzymes can be obtained from white of an egg, from yeast, and

other substances. These researches are likely to throw some light on the enigma of life.

The K. W. I. for Medical Research, Heidelberg

This institute has been divided into various sections.

(*a*) The Institute for Physics is under the guidance of Dr. Bothe, a distinguished authority on Nuclear Physics. A few years ago Dr. Bothe and his colleague Dr. Geiger placed polonium, a radio-active body emitting α-particles in contact with Beryllium, a light metal, and found that rays much more penetrating than the most penetrating γ-rays from any radioactive body come out of the combination. These researches were taken up by the younger Madam Curie-Joliot and her husband Prof. Joliot at Paris and Dr. Chadwick at Cambridge, and the latter showed that the penetrating radiations of Bothe and Geiger are "neutrons", a new fundamental particle of the same dimensions as atomic-nuclei, possessing no charge but the same mass as the H-atom, and capable of passing through miles of matter without difficulty.

The Institute is at present engaged in studying nuclear physics, the nature of cosmic rays. One member Dr. Kreuchen is investigating the so-called mitogenetic rays, supposed to be given off during moments of breaking up of animal cells.

(*b*) The Chemical Branch of the Institute of Medical Research is extremely famous now, as the young director Prof. R. Kuhn has done very important researches on vitamins and natural pigments. Prof. Kuhn and his associates have shown that a mol of β- carotene is the precursor of two mols of vitamin 'A' in the animal body.

$$C_{40}H_{56} + 2H_2O = 2C_{20}H_{30}O.$$

They have also published excellent research work on the vitamin 'B' group. Moreover, these researchers are excellent synthetic organic chemists and have synthesized numerous important substances.

(*c*) The Institute of Physiology is presided over by the eminent investigator, Prof. O. Meyerhoff, a Nobel Laureate in Physiology. This distinguished scientist carried on quantitative observation in many bacterial and physiological processes. He carried on accurate measurements on the amount of carbon assimilated per gram of ammonia oxidized by the nitrifying bacteria. He and his collaborators have published classical research work on the chemistry and physiology of muscular work and on the chemistry of fermentation. The Institute under the guidance of Prof. Meyerhoff is one of the best physiological laboratories in the world for scientific research.

(*d*) The Institute of Pathology is under the direction of Prof. von Krehl. In this institute diseases of heart muscles, children's diseases, specific dynamic effect of proteins in metabolism, respiratory quotients of different animals, and several other medical problems are being investigated.

The K. W. I. for Physiology of work, Dortmund

This institute is under the direction of Dr. E. Atzler. The influence of phosphates on muscular work, the influence of climate on muscular work and other problems are under investigation.

(*To be continued*)

N. R. D. & M. N. S.

Book Review

Head, Heart and Hands in Human Evolution —*R. R. Marrett, Hutchinson & Co., 1935. Pp 305.*

The book is a collection of seventeen different articles published on different occasions dealing with sociological, religious and technological aspects of primitive life prefaced by an introduction on the variety of human experience. Combined with a searching analysis and a critical appraisement of values there is a unity running through the whole series which deals in three parts with the intellectual, emotional and practical achievements of life from primitive times.

Anthropology to-day is often, as Wissler bluntly put it, "the European surveying the rest of mankind." Here, indeed, we are led to appreciate the insistence on the function of 'the higher gossipry' of Anthropology 'to consider human history universally and in its true perspective' with sympathy and fair-mindedness finding man at heart ever much the same and the human race 'engaged in some striking and characteristic attempts to transcend the level of brute existence'. Marrett had never been in the company of those with all the Victorian self-complacency and found primitive religion animistic and magical as contrasted with the later superior dogmas which he characteristically dubs as theological religion. He had repeatedly laid bare the graceful elements of faith, hope and charity being not at all absent in the primitive, and how the simple folk had their elaborate sacramental rites serving the same non-magical purposes as in the so-called religious systems of primitive man, and he had been the first to establish that the roots of religion lay not in animism in the Tylorean sense but in pre-animistic thresholds.

So students of primitive religion will welcome the second and third parts. He seeks first and foremost the beginnings of religion in the domain of feeling, considering the genesis of religion first of all in the light of the impulse or set of impulses that it arose to satisfy. In the heterogeneous compound or complex of religious feelings, awe, submissiveness tempered with admiration by which the primitive pays an uneasy respect to whatever overreaches and overrules his nautral powers, is found to play the leading role. Scientific curiosity is found largely to be the lineal offspring of religious awe. The part played by symbolism, the beginnings of religious custom, rites becoming the reflex of social feelings as well as of personal awe, dance leading to prayer by the sobering of crude sensibility, is explained in the author's characteristic style showing how the child of nature has 'learnt to turn bad luck into good by enduring the fast until the the feast is ready'. The intellectual element in primitive religion is examined with the aid of concepts from Africa, Australia, America, and Oceania. Several aspects of religious life in its functional developments in the material order have been brought together aptly in the third part. The psycho-sociological functioning of religion and its cultural fruition in trade, law, warfare, government, sanction, and custom have been treated most interestingly. The arts and crafts of the prehistoric man and of the modern savage complete the survey in many aspects.

But perhaps the cream of the book lies in the opening section dealing with evolution and progress, fact and value, race and society. Here will be found that insistence on spiritual values, that bringing to the forefront the attitude of a purposive creation, tendencies noticeable also in some recent biological writers who perhaps represent the phase, in the language of Russell, of awakening out of a long spell of sheer mechanistic materialistic interpretations, based on the studies of mere form without any consideration of the functions served. "A cocksure materialism is in fact a disease of thought that has attained epidemic proportions only in recent times" and 'one can discern a future for humanity consistent with a progress in spirituality along lines for which its natural impulses and aptitudes have designed it from the very first,' and such ideas will, we hope, more emphasize the catholic spirit of the anthropological science than ever. *P. Mitra.*

Annual Bibliography of Indian Archaeology for the Year 1933.—*Leyden, 1935. Pp. xiii 132, with nine plates and a portrait.*

This is the eighth volume of the valuable *Annual* of the Kern Institute. Research in Indian archaeology and allied subjects is progressing at such rapid strides, and the number of journals and independent monographs in different languages has of late so greatly increased that it is impossible to keep pace with the latest developments of knowledge without a periodical of this type. The Kern Institute deserves the sincere thanks of every student of Indian history and culture for taking upon itself the arduous task of collecting and classifying all that is published on Indology from year to year.

The volume opens with a short account of the life and works of Hendrik Kern, one of the leading savants of the nineteenth century. Then follows an interesting article on the excavations at Persepolis, carried on by Dr. Ernst Herzfeld on behalf of the Oriental Institute of the University of Chicago. Under the debris were found some excellent specimens of art, among them being reliefs depicting the ambassadors of various nations of the Achaemenian Empire, bringing tributes to the Emperor. The Indian tribute (Plate I) consists of two baskets of gold (we may remember here the statement of Herodotus that the Indian satrapy paid 360 talents of gold to Darius); an interesting local colour has been added here by the fact that the Indian bearer has on his shoulder a flexible yoke, the exact prototype of what is still now found in India. The figures are all bearded and some are naked up to the waist.

The archaeological progress made in India during the year under review has been described in some detail. Pending the publication of the *Director-General's Annual Report*, which is now overdue, we have to gather information from brief accounts such as we find here and in *Indian Art and Letters*, N. S., Vol. VIII, No. 2. Sir John Marshall has laid bare at Kalawan (Taxila) another Buddhist monastery, the biggest of its kind in Gandhara. From a Kharosthi inscription found here we know that the monastery was known as Chadasila, for the significance of which word we may now refer to an article by Professor Sten Konow in a very recent Hindi publication, *Bharatiya Anushilana-grantha* (Ojha Commemoration Volume), published from Allahabad. The inscription has of late been edited by the same scholar (*Epigraphia Indica*, Vol. XXI) and has led him to change radically his theories about Shaka-Kushana chronology.

Some excavations were also carried on at Nalanda (where a ninth monastery has been found), Gyaraspur (Gwalior), Rajgir (Bihar), and Paharpur (Bengal). At Old Delhi an extensive building, believed to be the palace of Muhammad bin Tughlaq has been unearthed.

In the Nizam's Dominions the Ghatotkacha *vihara* has been conserved and made accessible. We note with great satisfaction that the frescoes of Ellora have been scientifically preserved: we are assured that they will stand for two centuries more. The few specimens of early Indian painting that have come down to us should not be allowed to decay through carelessness. At Ajanta, we are told, a fresh fresco bearing the figure of a gateway like that of Sanchi has been noticed for the first time.

In a short article Mr. Burn examines the numismatic data in Mr. Jayaswal's *History of India*, and finds that most of his conclusions are unsound. Mr. Stapleton deals with some recent epigraphical and sculptural discoveries in Bengal. Attention is also drawn to Mr. K. L. Barua's article on the Coinage of Assam in the *Journal of the Assam Reasearch Society*, 1933. Professor Vogel reviews Mr. Ram Chandra Kak's *Ancient Monuments of Kashmir*, an interesting publication of the India Society.

The actual bibliographical and index portion of the book is as usual characterized by thoroughness in classification and richness of meterial drawn from European and Indian books and periodicals.

We find from the Foreword that the Nizam, the Maharajas of Travancore, Cochin, and Gaekwar, and the Commanding General of Nepal have substantially helped in the publication of the book. We hope that other native chiefs and learned bodies will, if necessary, help the Kern Institute in maintaining the regular publication of its useful *Annual*. We also feel that Indian scholars should co-operate to a greater extent by keeping the Editors informed of the vernacular publications.

A. Ghosh.

Physical Optics, *Third edition (1934).—By R. W. Wood, Published by the Macmillan Company, New York, U. S. A.*

Since the last revised edition of this book was published in 1911, much work has been done in the theory of optical phenomena, optical instruments and their applications to astronomical and other measurements. The book has, therefore, been largely re-written and much new matter has been added. And although as much as half of the older edition has been deleted to make room for the recent and more important developments the bulk of the book has increased by about twenty percent.

The additions that have been made are not only in the form of new chapters but also in the incorporation of new materials in the old ones thus making them more up-to-date. These latter in the earlier part of the book include Michelson's new determinations of the velocity of light and his measurements of star diameters, Hubble's observations of Döppler shifts due to the enormous velocities of the extra galactic nebulae, Rayleigh and Williams' interference refractometer, Paschen and Eagle's mountings of the concave grating etc. Although the descriptions in most cases lack completeness, their inclusion has greatly enhanced the value of the book and the new edition is a marked improvement on the previous one.

A distinct improvement is also noticeable in the treatment of interference spectroscopes. One would, however, have very much liked to see a more complete account of the theory of the Fabry Perot interferometer. A comparative discussion of the resolving powers of the different interference spectroscopes would have been appreciated.

A new chapter on the origin of spectra and another on Raman effect have been introduced. Bohr's theory of spectral radiation in the case of circular orbits has been discussed in full and a brief and qualitative account of elliptic orbits, spectra of alkali metals, molecular spectra etc. is also given. Apparently, no attempt has been made to give an idea of the effect of the finiteness of the nucleus, the spinning electron and complex spectra, although both the S and J quantum numbers have been explained later on in connection with Zeeman effect. Beginners will, however, find it a useful introduction to a further study of the subject.

The experimental arrangements, employed to produce Raman effect, have been described, and a qualitative theory of the effect and its relation to far and near infra-red spectra have been discussed.

Fluorescence and phosphorescence have been dealt with rather in great detail covering, as it does, the subject matter of three separate chapters, *viz.*, Resonance radiation and fluorescence of atoms, fluorescence of molecules and of liquids and solids. This method of division, however, seems logical, and obviously helps in understanding the fundamentals of the phenomena.

The chapters on magneto-optics and electro-optics have been made up-to-date by the inclusion of the quantum theory of anomalous and normal Zeeman effect, the theory of Stark effect, the internal photo-electric effect etc.

As already mentioned, a large portion of the old edition has been deleted some of which, we find, are quite useful and could have been retained with advantage. Of the omissions that have been made one fails to understand why subjects like Airy's treatment of diffraction by a circular aperture, theory of the concave grating, the equations for the echelon grating, which are important from the point of view of students preparing for a degree, have been left out.

The book is, on the whole, a marked improvement on its previous editions and one of the best text-books on optics. We, however, feel that the theoretical side of the subject has not been as well dealt with as is necessary for making a proper study of the subject. On the other hand, too much stress has been laid, as in the previous editions, in describing minute details of experiments and technique employed to carry them out, most of them embodying the author's own experiences—many of which could have been well omitted.

K. Majumdar.

Composition of Boiled Oil

M. Goswami

Boiled oil is mainly prepared from linseed oil by heating with catalysts in presence of air at 150°-200°C. It is used in various arts and industries such as in the preparation of paints, varnishes, printer's inks, water proof fabrics, imitation leather, etc., and its main utility depends upon its property of quick drying.

Boiled oil presents two questions of utmost importance, the true answers of which may revolutionize the whole process of its manufacture in the way of finding newer and cheaper raw materials and may thus help the industry to stand on its foot against the terrible competition of the cellulose esters: they are:—

(*i*) How the boiled oil dries, or through what chemical or physicochemical changes the oil dries up after it is exposed to air and light; and

(*ii*) Why the boiled oil dries or what change in the composition of raw linseed oil is introduced during the process of "boiling with catalysts in presence of air" that is responsible for the characteristic quick drying property.

Although it cannot be said that a definite answer has been given to the first question yet it appears quite certain that a certain amount of polymerization and oxidation takes place during the process of drying. As the present article is concerned with the second one (*ii*), the link between the two and the points of discussion before us may be indicated in the following enquiry: if polymerization and oxidation take place during drying, then what compounds are there in boiled oil or, for the matter of that, what compounds have been formed when the raw oil has been 'boiled', which are responsible for the special property?

The average composition of raw linseed oil and its characteristic values are given in the following table:

Composition of oil.	Composition of separated fatty acids.	Sap. value.	Iodine value.	Acetyl value.
Mixed glycerides of oleic, linolic, linoleinic, stearic, palmitic and myristic acids	Unsaturated acids 88%: Oleic acid 1·6%: Linolic acid 58·9%: Linoleinic acid 22·8%: Saturated acids 8%: Glyceryl radicle 4%:	189-192	179-190	Negligible

After 'boiling' it is found that the acetyl value changes enormously: the saponification value remains constant whilst the iodine value decreases gradually with the rise in temperature. An increase in acetyal value indicates the formation of hydroxy acid glycerides during the process of boiling.

In the preparation of boiled oil there are three factors which operate simultaneously *viz.*, (*i*) heat, (*ii*) air, and (*iii*) catalysts. The action of these on the different constituent fatty acid residues of linseed oil, already given in the foregoing table, would be different. Hence the particular property of boiled oil is due to the combined action of the agents referred to on oleic, linolic and linoleinic acid residues, the glycerides of saturated acids being known not to be affected under the circumstances. In arriving therefore at a proper conclusion we must consider the individual effects of those factors on each of the unsaturated acid radicles.

We should also examine the behaviour of hydroxy acid glycerides, responsible for the acetyl value in boiled oil under the condition of boiling pan. Castor oil mainly contains ricinolein whilst olein and linolein are characteristic of cotton seed oil. At first the effects of heat and air on these oils may be consi-

dered. Castor oil, when heated alone, suffers the following changes in values :—

(*a*) Iodine value increases from 83 to 100 ;

(*b*) Acetyl value decreases from 150 to 67.

Saponification value does not change and there is gelatinization due to polymerization. These changes show definitely that water is eliminated at the expense of the hydroxy groups with the production of increased unsaturation of particular nature responsible for the polymerization.

In the case of cotton seed oil, action of air and heat results in the enormous increase of acetyl value. This shows the formation of hydroxy acid. In fact, boiled cotton seed oil simulates castor oil in many properties.

The catalysts used in the preparation of boiled oil are mainly linoleates and resinates of manganese, cobalt, lead, and nickel ; they are very unstable compounds and as such, they are expected to be decomposed under the conditions prevailing in the boiling pan. Undoubtedly, therefore, the particular metals in finely divided state come to play in the process. The action of metals like nickel in the finely divided state, in the course of the hydrogenation of cotton seed oil, has revealed a very interesting result. There is not only hydrogenation, *i. e.*, saturation of double bond but also production of an unsaturated compound, namely *iso*leic acid $CH_3 \cdot (CH_2)_6 \cdot CH = CH \cdot (CH_2)_8 \cdot COOH$, an acid isomeric with oleic acid but having the double bond in 10 : 11 position. The peculiarity of this acid is that even under the favourable conditions of hydrogenation, it refuses to be saturated.

This peculiarity and formation of the acid can only be explained if we consider that there has been migration of double bond of linolic acid residue and there has been formation of an intermediate compound containing conjugated double bond :—

$$
\begin{array}{l}
CH_3\,(CH_2)_4 \cdot CH \\
\qquad\qquad \| \\
\qquad\qquad CH - CH_2 - CH \\
\qquad\qquad\qquad\qquad\quad \| \\
\qquad\qquad\qquad\qquad\quad CH\,(CH_2)_7 \cdot COOH
\end{array}
$$

$$\longrightarrow$$

$$
\begin{array}{l}
CH_3\,(CH_2)_5 \cdot CH \\
\qquad\qquad \| \\
\qquad\qquad CH - CH \\
\qquad\qquad\qquad\quad \| \\
\qquad\qquad\qquad\quad CH\,(CH_2)_7 \cdot COOH
\end{array}
$$

This intermediate compound has then accepted only two hydrogen atoms in accordance with the well-known behaviour of compounds of such nature to give *iso*leic acid :

$$
\begin{array}{l}
CH_3\,(CH_2)_5 \cdot CH\ldots\ldots \\
\qquad\qquad\quad | \\
\qquad\qquad\quad \vdots \\
\qquad\qquad\quad CH - CH \\
\qquad\qquad\qquad\quad | \\
\qquad\qquad \ldots\ldots CH\,(CH_2)_7 \cdot COOH + H_2
\end{array}
$$

$$\longrightarrow CH_3\,(CH_2)_6 \cdot CH - CH\,(CH_2)_8 \cdot COOH.$$

It is therefore extremely probable that similar transference of double bonds and therefore similar formation of compounds containing conjugated double bonds take place in the boiling pan.

Experiments have been done on ricinolic acid—the hydroxy acid characteristic of castor oil—with a view to the elimination of water molecule, and an acid containing two double bonds has been obtained to which no other constitution* than $CH_3\ (CH_2)_5$ $CH = CH - CH = CH \cdot (CH_2)_7 \cdot COOH$ can be given, and it must have been formed in the following way :—

$$
\begin{array}{l}
\ldots CH_3\,(CH_2)_5\,CH - CH_2 - CH = CH \cdot (CH_2)_7\,COOH \\
\qquad\qquad\qquad\ \ | \\
\qquad\qquad\qquad\ OH
\end{array}
$$

$$\longrightarrow$$

$$CH_3\,(CH_2)_5 - CH = CH - CH = CH\,(CH_2)_7 \cdot COOH$$

This acid is now regarded to be identical with *iso*lee acid.

It is therefore pertinent to say that similar elimination of water molecule takes place when castor oil is heated and the acceptance of this view clearly explains its augmentation of iodine value and decrease of acetyl value.

It likewise explains the easy plymerization of the subsequent product as it is well-known that compounds containing conjugated double bounds easily polymerize. Considering, therefore, the augmentation of acetyl value of linseed oil when boiled, the formation of *iso*leic acid in the hydrogenation of cotton seed oil, the experiments on castor oil and ricinolic aied and the results obtained when cotton

*The acid in question is different from linolic acid having the constitution $CH_3\,(CH_2)_4 \cdot CH{=}CH \cdot CH_2 \cdot CH{=}CH\,(CH_2)_7$ COOH, the only other possibility if the elimination takes a different course.

seed oil is heated in presence of air, we are led to conclude that during the boiling of linseed oil in contact with catalysts and in presence of air :—

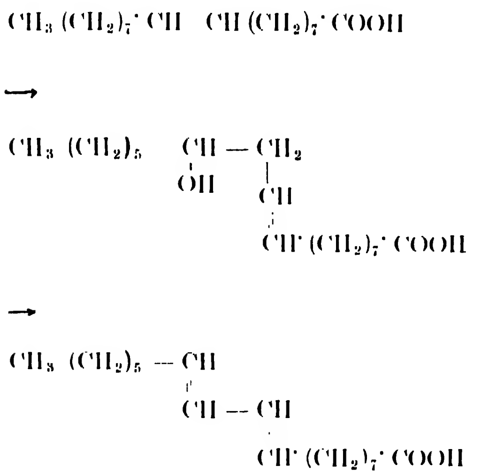
(*a*) there is formation of hydroxy acid,

(*b*) there is elimination of water molecule from the hydroxy acids so formed, and finally

(*c*) there is transference of double bond so as to produce conjugated state.

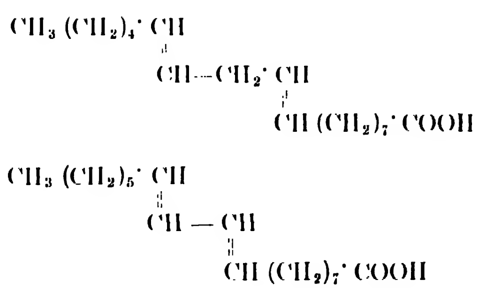
If we accept this view then the picture of the transformation of oleic, linolic and linoleinic acid residues during the boiling of linseed oil would be the following :—

Oleic acid

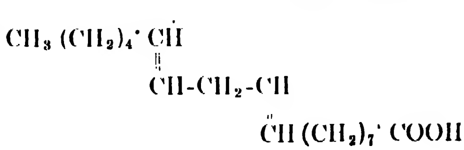


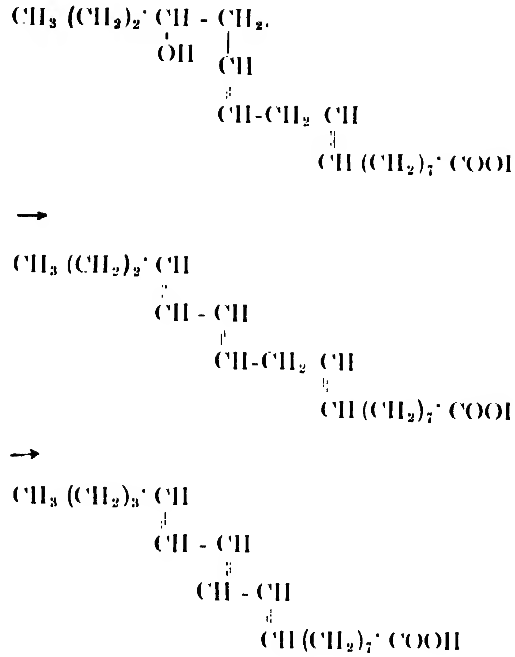
Linolic acid

(*a*)

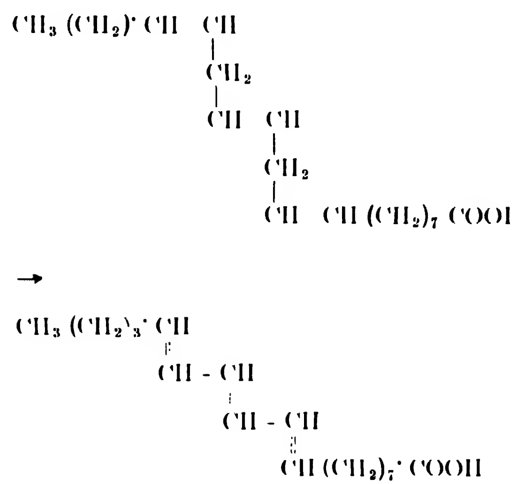


(*b*)





Linoleinic acid



The production of such compounds containing conjugated double bonds which would surely simulate the behaviour of compounds like isoprene, butadiene etc., in the point of polymerization and oxidation—seems to be the most probable explanation of the drying of boiled oil. This view, although it explains

other properties, does not clear one issue *i.e.*, the decrease in iodine value of boiled oil. The scheme already referred to, provides the formation of hydroxy acid and of compounds of higher saturation; this latter would undoubtedly give rise to higher iodine value whereas in practice we do not get such. It is possible that internal compensation of unsaturation takes place between molecules in the following way:

$$\begin{array}{l} CH_3(CH_2)_5 \cdot CH - CH{-}CH - CH\,(CH_2)_7 \cdot COOH \\ \quad + \\ CH_3(CH_2)_5 \cdot CH - CH{-}CH - CH\,(CH_2)_7 \cdot COOH \end{array}$$

$$\begin{array}{l} CH_3(CH_2)_5 . CH - CH{=}CH - CH\,(CH_2)_7 \cdot COOH \\ CH_3(CH_2)_5\, CH - CH{=}CH - CH\,(CH_2)_7 \cdot COOH \end{array}$$

and owing to simultaneous increase and decrease in unsaturation the iodine value is not much affected. Experiments of Morrel and others also go to support such partial polymerization.

Hardening Shellac

R. W. Aldis

Lac Research Institute, Ranchi.

Lac, or shellac as the purified form is called, is the resinous incrustation of a small insect which lives on certain Indian trees. This resin is of value in many industries *e. g.* it is used in the manufacture of gramophone records, sealing waxes, varnishes, leather and paper finishes, inks, cements, fireworks, emery wheels, mouldings, electrical insulators etc. To meet the demands of these various industries India exports about 5,00,000 maunds of lac and shellac annually.

It has been recognized for many years that the usefulness of shellac would be further increased if improvements could be made in certain properties *e. g.* water, heat and abrasion resistance. The possibility of achieving such improvements has been indicated by recent researches.

The advent of synthetic resins of the phenol-formaldehyde condensation type introduced a new concept into resin chemistry. These resins possess the remarkable property of 'thermo-hardening', *i. e.* although quite fusible and soluble when first formed they readily become tough and infusible on application of moderate heat.

The utilization and application of this property has been largely responsible for the rapid commercial development of this type of material of which 'Bakelite' is perhaps the best known example.

Shellac also possesses this property of 'thermo-hardening' to a limited extent and efforts have been made to develope the natural resin on the lines which have proved so successful for its synthetic rival.

Certain practical use has been made of this property of shellac *e. g.* in the manufacture of grinding wheels, laminated mica etc., where oven baking imparts marked improvement; but efforts to utilize the reaction in other industries *e. g.* the manufacture of heat resistant mouldings, have met with but moderate success. This failure is chiefly accounted for by certain peculiarities of the 'heat-curing' of shellac.

If heated to about 220°C (or a lower temperatures for longer periods) shellac solidifies to a tough, horny mass, the small quantity of water eliminated during the reaction producing a blistered appearance. This 'cured' material, although softened to a rubber-like mass on heating will not melt at temperatures

up to, and somewhat above, the temperature at which the initial 'curing' occurred. Preliminary work, conducted at the Indian Lac Research Institute, Ranchi, indicated that certain factors had a profound effect on the time taken for shellac to reach this 'cured' state.

It was found that certain chemical reagents when added in small quantities to shellac produced considerable change in the time taken for the shellac to heat harden. Retarding materials included alkalis and solvents; while accelerating materials included acids, ester-forming catalysts, ammonia and substance liberating ammonia *e. g.* hexamethylene-tetramine, urea, thiourea etc.

Unfortunately this discovery does not mean that shellac can be directly utilized in the same way as 'Bakelite' in, for example, the moulding industry. This is because the hardening of shellac is fundamentally different in one respect in that while pressure is an acceleratory of 'Bakelite' polymerization it is a powerful retarder of shellac 'curing'. Moreover, if cured shellac is subjected to heat and pressure in the presence of water *e. g.* by autoclaving, it can be converted back to fusible shellac. We have, therefore, a reversible reaction which may be expressed,

$$\text{Shellac} \rightleftharpoons \text{'Cured' shellac} + \text{water.}$$

This effect of pressure is a serious obstacle to progress in the utilization of shellac and ways of circumventing it are being actively investigated. A partial success has already been achieved and mouldings with heat resistance intermediate between 'Bakelite' and untreated shellac have been prepared.

The changes produced by heating shellac can also be brought about to a certain extent by long storage in a warm climate. The excellent durability and appearance associated with lacquer applied several decades ago are largely due to this effect. The problem of bringing about these hardening processes in a seasonable time at room temperatures has recently been investigated. Amongst those reagents which were powerful accelerators of the heat hardening of shellac one in particular, urea, was of special interest in that the 'acceleration factor' or 'acceleration efficiency' increased considerably with lowering of the temperature of the reaction, and indicated the possibility that these reagents might have some effect even at room temperatures. On testing this was indeed found to be so. A shellac varnish film containing urea was found to have developed in a few days a marked insolubility in alcohol and improved hardness and water resistance such as would normally only develop in a shellac varnish film after many years. It is too early to predict the full significance of this discovery, but suffice it to state that current experiments using selected proportions of 'accelerator' and certain plasticizers are giving extremely hopeful results.

It will be seen therefore that both at elevated and at room temperature it is possible to bring about rapidly in shellac a state of polymerization and its attendant improvements in heat and water resistance. It is hoped that commercial development of these effects will soon become apparent.

Is the Velocity of Light Constant

In recent years much discussion has appeared about the hypothesis that the velocity of light is variable with time. In 1927 De Bray compiled a table of the velocity of light from the original communications contributed by the investigators themselves, starting from the famous Fizeau-Foucault toothed-wheel method in 1849 and finishing with the Michelson experiment in 1926. After a discussion about the trustworthiness of the different results, about 12 were discarded out of 21 and De Bray pointed out that "except a pair of practically simultaneous values obtained in 1882 the final values showed a secular decrease of velocity." The lowest value was the last one *i. e.* for 1926 and it was 299, 796±4 Km/sec.

After the publication of that table two more determinations of velocity were made.

1. Karolus & Mittelstaedt.[2]
   (1928) 299, 778±20Km sec.

2. Pease and Pearson[3] (in continuation of Michelson's work.)
   (1933)- 299, 774 ±1 or 2Km sec.

Thus in a note to *Nature*[4] De Bray showed the values for ten years as follows :—

1924 – 299. 802±30Km/sec
1926 – 299, 796±4 "
1928 - 299, 778±20 "
1933 - 299, 774±1 or 2 "

By the application of Cauchy[5]'s Method to these values, De Bray showed that the velocity of light followed a linear law *viz*.

$C_{km\ sec} = 299,900 - 4T_{1900}$ years.

T_{1900} – date after 1900 A. D.

Subsequently, however, De Bray[6] pointed out that if all values of the velocity as compiled by him are retained and plotted against the years, a periodic curve is obtained showing a periodic variation of the velocity of light.

The untenability of this hypothesis of the variation of the velocity of light was shown by Wilson[7] indirectly from the known data about the measurement of the standard metre in terms of the wave-length of the standard cadmium line. It was also shown by Kennedy[8] from direct observation that a change in the velocity of light as put forward by De Bray would cause a shift in the interference pattern too great to escape detection.

Again in 1934, Edmondson[9] from the measurements correlated by De Bray and from other considerations showed that the variations as shown by De Bray is not a continuous decrease, but is a periodic function of time. According to him, the observed values are well represented by

$$C = 299,885 + 115 \text{ Sin } \frac{2\pi}{10} (t - 1901)$$

Where C = velocity of light in Km sec.
t = the date of observations A.D.

As pointed out before, De Bray also found this periodic variation if all the values were retained and Edmondson's equation quite suited his curve. Whether the variation is a periodic phenomenon or obeys a linear law can only be decided by a determination of the velocity in the year 1911 ; for by the periodic relation it should be 299, 885Km/sec while by the linear law proposed by De Bray it will be 299, 736Km/sec.

Very recently, however, Kennedy[10] has adduced evidence against this theory of Edmondson from experimental observations on the interference of light and also from astronomical data. There cannot be any doubt about the superiority of the interference method in deciding about the constancy of the velocity of light, and Kennedy shows that the variation of the velocity in 1934 as obtained from Edmondson's equation would produce a shift in the fringes which was possible for him to detect in the arrangement made in his experiment undertaken about 1930. Moreover, from a theoretical deduction

he has also shown that, according to De Bray's theory, the red-shift of the nebular lines would be absurdly high, and Edmondson's theory would demand an alternate red and violet-shift—the shift in both theories to be super-imposed on Doppler or other shifts.

B. N. C.

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1. *Nature 120*, 602, 1927.
2. *Phys. Z.* 698-702, 165-167, 1929.
3. *Nature 133*, 169, 1934.
4. *Ibid 133*, 464, 1934.
5. *Engineer* Sept 13, 1912.
6. *Nature 133*, 948, 1934.
7. *Nature 130*, 25, 1934.
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9. *Ibid 133*, 759, 1934.
10. *Phys. Rev. 47*, 533, 1935.

Earthquake Shocks Recorded by the Seismographs at Alipore Observatory in July, 1935.

Date	Time of beginning (I. S. T.) H.	M.	S.	Intensity.	Epicentral distance.	Remarks.
4. 7. 35	8	19	57	Slight	340 miles	Reported to be felt in Darjeeling and Jalpaiguri Districts.
5. 7. 35	23	28	23	Moderate	1620 „	
7. 7. 35	18	58	42	Slight	2460 „	
9. 7. 35	10	36	24	Tremor	—	
9. 7. 35	18	41	28	Tremor	—	
11. 7. 35	2	9	45	Tremor	—	
11. 7. 35	14	19	53	Tremor	—	
12. 7. 35	7	20	11	Tremor	—	
15. 7. 35	20	6	8	Tremor	—	
16. 7. 35	21	55	11	Moderate	2070 miles	Reported to be felt in Formosa Island.
17. 7. 35	16	53	4	Tremor	—	
19. 7. 35	6	28	29	Moderate	3420 miles	
23. 7 35	9	34	56	Tremor	—	
26. 7. 35	14	46	47	Slight	1060 miles	
26. 7. 35	16	5	20	Moderate	1420 „	
28. 7. 35	10	58	27	Slight	1370 „	
29. 7. 35	13	21	20	Moderate	7860 „	
30. 7. 35	4	51	26	Slight	1470 „	
30. 7. 35	11	26	45	Slight	2840 „	

Notes and News

IN his very illuminating address delivered before the Indian Social Club and the Indian Progressive Writers' Association in London some time ago, Dr. Suniti Kumar Chatterjee, Khaira Professor of Indian Linguists and Phonetics at the Calcutta University and Chairman of the Indian Section of International Congress of Phonetics, put in a very strong plea for the adoption of the Roman alphabet for all the vernaculars and classical languages of India. In tracing the early history of the introduction of the Roman character in this country, he said that it was first brought out to India by the Portuguese missionaries in the sixteenth century, who adopted it for writing the Konkani dialect of Goa where it is still used by a large population of converts to Roman Catholicism. Though since then a few sporadic efforts have been made here and there in its favour, no concerted action has been taken so far. Regarding recent attempts he referred to Sir Daniel Hamilton's successful experiment of teaching the village children in his estate at Gosaba in the Sundarbans, where Bengali is taught in the Roman script but on a strictly phonetic basis, devised by a committee of which Dr. Chatterjee is a member.

Regarding the advantages of a Roman script, Prof. Chatterjee particularly emphasized three important factors: firstly, on account of the very simple nature of the Roman letters, they are more easily learnt than the complicated vernacular alphabets of India with large number of complex symbols; secondly, the legibility of the type-faces is far in excess than that of the Indian ones, with far fewer examples of blurred or broken letters; and thirdly, printing in Roman characters is both easier and cheaper than it is in any of the Indian scripts, the reason being that the former requires only about 150 characters as against anything between 450 to 700 in the case of the latter.

The reader of SCIENCE AND CULTURE is aware that an editorial on a common script for the languages of India appeared in the August number of SCIENCE AND CULTURE, in which a full history of the case was given, but we refrained from giving any decided opinion on the respective merits of the Roman and Devnagri scripts. To this illuminating lecture of Prof. Chatterjee, we invite the attention of those who prefer a modified form of Devnagri to Roman which, according to the protagonists of Devnagri, has no merit at all. Prof. Chatterjee says, "the greater portion of the civilized world uses the Roman script, and in the present age when our culture is becoming more and more international, the advantages of following in line with the rest of the world are obvious." We wish to point out that if the common Indian script which, we hope, will very soon see the light of the day is Roman, not only will the literary and cultural contact of one province and another in this country be much more intimate and effective, it will also enable a non-Indian to have easy access to our literatures, and thus understand and appreciate them far more easily than he would have done had he to enter into the complications of the Indian alphabet. And thus, when it begins to be studied by the outside world, it will be easier for an Indian literature to receive its due recognition, which at present it hardly gets in view of the ignorance of the outside world about it, and therefore of its real worth.

We very much welcome and appreciate the suggestion made by Prof. Chatterjee that by way of a start the vernacular press in this country should print at least one column in each issue in the Indian-Roman script. Doubtless this will make the reader grow accustomed to reading the script with ease, and in the long run he will, we have no doubt, read and write it as easily and naturally as he does in the case of the alphabet in vogue.

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THE quality and the quantity of the drinking water supply to the citizens of Calcutta have become the current topics. Various articles and

criticisms and editorial notes pointing out the defects in the system of the water-supply as also suggestions for the betterment of the quality and quantity of the water find suitable place in the columns of the daily newspaper. The question of wholesomeness of water has thus duly attracted, after a long time, attention of the public. The citizens of Calcutta for years, as it appears from the comments and opinions expressed in the newspaper, were hardly in possession of facts regarding the actual nature of the whole system of water-supply of Calcutta. The system in short is what is called the open filtration system, this has not only its beneficial aspects but in the tropics also creates considerable amount of trouble regarding proper control of what is generally called the zoological growth in the filter beds. The filtration arrangement of Calcutta is thus naturally associated with many disadvantages which are mainly of biological nature. The raw river-water is first pumped from the river into the settling tanks and then into the storage tanks and from there flows into a large number of filter beds. The water thus filtered is then collected in individual collecting wells from which it is passed on to a central collecting well. From this collecting well it is passed on to the reservoirs at Tallah from which it is finally pumped throughout the city by means of distribution system of a network of underground pipes. In this process, we thus find that there are hree stages in the life cycle of the Calcutta Filter water supply :—(*i*) the whole filtering arrangement at Palta, (*ii*) the storage of water in the Tallah reservoir and (*iii*) the underground pipe system and the tap system from which the water finally comes out in the residential quarters. Occasional findings of dirty sediments and prevalence of disease in Calcutta led the public to become suspicious as regards the healthy nature of the water consumed. Various defects have therefore been pointed out from its bacteriological, medical and engineering aspects. Thus, for example, the recent bacteriological examination resulted in the submission of an illuminating joint report on the nature of the water drunk by the Calcutta public. Although this bacteriological test is but one of the tests of real scientific sanitary analysis of water, it has proved beyond doubt the unwholesomeness of the drinking water of Calcutta. The report has emphasized also the possible sources of pollution at Palta and subsequently contamination in the underground pipes. Thus we have now to a certain extent definite data regarding the two important points on the defects of the water-supply-system : Firstly, at its source at Palta, and secondly, in the leakages in the distribution system. The report referred to above, thus has confirmed the possible sources of infection and pollution. The pollution at its source is mainly of biological and physico-chemical nature dependent partly on the mechanical control of filtration and other arrangements at Palta. The defects in the pipe-system are also of partly biological nature but mainly bacteriological, and dependent, as usual, on the engineering system of the underground distribution arrangement of the pipes.

The position is therefore to a certain extent now clear, and we are at present faced with the problem of how to rectify these two defects affecting the drinking water-supply of Calcutta which is indeed of vital importance. Chlorination which is generally done in these cases is no doubt a preventive measure for the control of bacteria but at the same time chlorination in overdoses is considered to have harmful effects on the human system and on the metallic portion of the underground pipes in which corrosion becomes rapid, expediting leakages. Chlorination may have to be done but perhaps not in the way as it is practised now. Leakages have to be stopped and rectified as early as possible. Such detection of leakages is a very laborious job no doubt. By the modern engineering system and the help of examination by means of "Pito tubes", detection of leakages and subsequent rectification of such defects may not be an impossible task. Finally, a thorough biological investigation with the help of a team-work of algologist, proto-zoologist, bacteriologist, chemist, physico-chemist will have to be called for. Such a board of scientific workers control the water-works of the leading cities of the world. It is high time that co-operation of these of with the Corporation authorities and their employees, together with valuable suggestions and criticisms from the public, will, I am sure, raise the standard of purity of drinking water of Calcutta to such a height as is worthy of the econd city of the British Empire.

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IN a very entertaining speech given to a Poona audience at a meeting held in the evening of

Aug. 1, 1935, under the auspices of the Deccan Agriculturists' Association, Sir T. Vijayraghavachari, Vice-President of the Imperial Council of Agricultural Research, adduced facts and figures to show that India had made good progress in sugar industry ever since the passing of the Sugar Protection Act in 1932. At the present rate of progress there will be little or no import of foreign sugar in the course of the next four years. According to Sir Vijayraghavachariar there are today no less than 113 factories with a total output of 600,000 tons of sugar annually as against 32 such factories (of which only 27 were in working order) in 1931-32 with a total outturn of 90,000 tons of sugar. This increase in the number of sugar factories is responsible for the decrease of foreign sugar, which used to be anything between 800,000 to 10,00,000 tons a year formerly when the sugar Protection Act had not been passed, but which has now happily come down, according to the figures given by the last year's official report, to only 2,23,000 tons. The production of 600,000 tons of sugar in India means that Rs.1,250 lakhs, at the present price of sugar, was being retained in this country instead of its flowing out into foreign lands. Of this sum of Rs. 1,250 lakhs, Sir T. V. Chariar informs us, the sugar cane-grower got Rs. 760 lakhs, the wages and salaries of the employees amounted to Rs. 170 lakhs and transport charges were 100 lakhs. Thus the total expenses of the Indian sugar capitalist are Rs. 1,030 lakhs, and the difference between Rs. 1,250 and this latter sum, which works out to be Rs. 2,20 lakhs, must be accounted for as the net profit of the sugar capitalists in India. There being only 113 factories, the adverage gain of a factory is, we may say, Rs. 154,000 a year, which shows that there is still field for the sugar capitalist in this country to start more factories, and turn out more sugar. Calculating on the basis of the above figures we find that 190 mills are required to meet the total demand of India. Thus there are yet fields for 17 mills more in India. The general idea of the public in India that this line is blocked is therefore found to be without foundation.

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IN a very useful note on the reserves of good quality coal in India recently published by the Department of Industry and Labour, Sir L. L. Fermor F. R. S., Director of Geological Survey of India, calculating on the basis of the figures given in the memoirs of Dr. C. S. Fox, writes that India can now reckon on about 4500 million tons of good quality coal. According to Sir Lewis Fermor, this will last for 200 years if cent per cent extraction is secured, assuming that the average annual consumption of good coal in India does not exceed 225,00,000 tons, but unless something effective is done to cause an alteration in the system of mining coal in India, not more than 50% will be dug out. Even if the annual consumption increases to 30,000,000 tons, India's coal reserve will supply her for 150 years with cent per cent extraction. The note of Sir Lewis Fermor is very refreshing to read. It shows that if India can better her system of coal mining, she can meet her demand of good quality coal to the fullest. Thus there seems to be no cause for anxiety during the next few generations.

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INDIA produces during season time a vast quantity of fruit of such varieties as no other country in the world does. But the seasons are short and though usually there is a surfeit of fruits during the season time, none can be obtained when the season is over. The mango season, for example, lasts barely over two months. How fine it would be if methods could be devised for the preservation of mango during the whole year, so that Benares *langra* can be served at the tables during winter and early spring. It would open up a vast trade, and render a partial solution of food problem for the poor.

In the usual methods of preservation resort is made either to convert the fruit into some sort of condiment, or the properly treated fruit is canned in sealed containers. But in these methods the original taste of the fruit is lost. Recently a new method has been coming into use, which promises to keep the fruit fresh for over a long time. This is effected by storing the fruit in a sealed chamber maintained at a temperature which is determined by research work and replacing the oxygen of the air partially by carbon dioxide. Thus it has been found that varieties of apple when preserved at a gas-tight store at a temperature of 5°C, and with 10% of the oxygen replaced by carbon dioxide, and

provided ventilation is controlled properly, keeps remarkably well for 12 months. Such researches are being carried out at the Ditton Laboratory of the Department of Scientific and Industrial Research; and the results obtained have been very promising. As a result, a large industry is being gradually built up in Great Britain, and the businessmen interested in this industry have signified their approval of the research work by presenting five storage tanks to the Laboratory. *The Nature* reports that the first gas-store was built up in Great Britain in 1929, and to-day there are 40 gas stores in operation with a total capacity of 100,000 bushels.

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THE report of the Department of Agriculture, Bengal, for 1933-34, states that of as many as seven important schemes of agricultural research during the year there were two new schemes, one for fruit research at Krishnagar and the other for investigation work into the costs of sugarcane cultivation. Agricultural research was also carried on at the Universities of Calcutta and Dacca with grants from the Imperial Council of Agricultural Research. The report further states that there was also an increase, in the year under review, in the cultivation of tobacco, one of the few crops that were not affected by depression. Though the season was on the whole a good one both for winter and autumn crops, and fair for *rabi* crops, the prices of rice and jute were low in view of the adverse economic conditions. During the year there were 56 agricultural schools with 3030 students receiving education on the subject, both theoretical and practical. It was a year of depression for sericulture, foreign, especially Japanese, competition affecting the market. One of the most pressing questions is the improvement of the cattle of the Province. In most districts the breeds give poor plough-cattle and poorer milkers and the best cattle are those imported from outside.

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AN extensive programme of lectures and 'refresher classes' has been arranged by the London County Council. This will enable the county teachers to keep abreast with the latest educational developments and widen outlook on literary, historical and humanistic subjects which doubtless help to create a solid back-ground for teaching. Among the speakers there are such distinguished men as Sir William Rothenstein, Sir E. Denison Ross, Lord Passfield, Mr. F. S. Smyth, the leader of the Himalayan Expedition in 1931, and others. Lord Zetland will deliver a lecture on 'The Indian Constitution.' It is needless to emphasize that such lectures are necessary to keep the teachers in charge of childrens' education in touch with the modern developments in all directions, and to check a fossilization as is generally found in the school teachers in India. The Corporation of Calcutta and the other municipalities will do well to emulate the noble example of the London County Council. In India there is no dearth of learned men whose addresses will prove to be of immense benefit to teachers.

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IT has been announced in *Revue anthropologique*, Oct-Déc, 1934, that the sixteenth session of the International Congress of Anthropology and Prehistoric Archaeology (xvi^e Congrès International d' Anthropologie et d'Archéologie Préhistorique) will be held at Brussels on 1st-8th September, 1935. His Majesty the king of Belgians has graciously consented to be its chief patron. There are altogether five sections in it, *viz*. (1) Morphological and Functional Anthropology Blood Groups: (2) Human Palaeontology- Prehistoric Archaeology: (3) Heredity - Eugenics– Selection : (4) Psycho-sociology Criminal Anthropology : (5) Ethnography-Folklore-Linguistics History of Religions.

A committee has been organized to devise ways and means with Prof. C. Fraipont of the University of Liége as its President, and Dr. L. Dekeyser as its General Secretary. An International committee of Scientific Preparation (Comité International de Préparation Scientifique) has also been constituted with the following members : Prof. C. Fraipont (Belgium), Dr. M. Reygasse (Algeria and North Africa), Prof. R. Thurnwald (Germany), Prof. Castellanos (Argentine), Dr. Koppers (Austria), Dr. Soren Hansen (Denmark), Prof. Pacheco (Spain), Prof. C. Peabody (U. S. A.), Dr. Moore (Esthonia), Prof. Karlo Hilden (Finland), Dr. Louis Marin (France), Dr. J. Koumaris (Greece), Prof. J. Kleiweg de Zwann (Holland), Prof. Myjsberg (Dutch Indies),

Prof. S. Sergi (Italy), Prof. R. Torii (Japan), Prof. Ballodis (Lithunia), Dr. A. Genin (Mexico), Dr. Schreiner (Norway), Prof. Poniatowski (Poland), Prof. H. Monteiro (Portugal), Prof. da Silva-Correia (Postugese India), Dr. Minovici (Rumania), Dr. Hindze (Russia), Dr. Arne (Sweden), Prof. E. Pittard (Switzerland), Dr. Schranil (Czechoslovakia), Dr. Paulina Luisi (Uruguay), Dr. Zupanich (Yugoslavia).

Simultaneously with this Congress, the sixth general assembly of Institut International d' Anthropologie is also expected to be held at Brussels. Communications and subscriptions (80 frcs.) should be sent either to the General Secretary of the Congress, 9, Rue des Sablons, Brussels, or to the Secretary, Institut International d' Anthropologie, 15, Rue de l' École-de Medicine, Paris.

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THE Director of Agriculture, Bihar and Orissa, announces that in memory of Mr. E. J. Woodhouse, late Economic Botanist and Principal of Sabour Agricultural College who was killed in action in France 1917, a biennial prize in the form of a silver medal and books of a combined value of Rs. 100/- will be awarded to the writer of the best essay on a subject of botanical interest to be selected from the list noted below. The length of the essay should not exceed 4,000 words. The competition is open to graduates of Indian universities and to diploma-holders and licentiates of recognized agricultural colleges in India, who are not more than 30 years of age on the date of submission of their essays. Papers should be forwarded to the Director of Agriculture, Bihar and Orissa, Patna, before November, 1935. Failing papers of sufficient merit no award will be made. Essays must be typewritten on one side of paper only.

1. Intergeneric hybrids and their importance to agriculture.
2. The problem of rust of wheat in India.
3. The constancy of agricultural and botanical characters of paddy and their suitability for being used in a scheme of classification.
4. Rotation of crops in relation to the eradication of weeds.

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A prize of two thousand gold marks is announced by the committee of Zeitler's Studien-Haus Endowment for the best research on the mechanism of assimilation of CO_2 by plants in the presence of sunlight. It is well-known that the plants absorb solar energy and convert it to chemical energy. The carbon dioxide of the atmosphere is converted into carbohydrates with the evolution of oxygen. The way in which the light energy completes the chain of reactions is still unknown. The methods adopted for the study of this problem are to be described and new possibilities have to be explored by means of which one can get an insight into the process of assimilation which is so fundamental for life in all forms on our globe.

The prize is open only to Germans and is to be written in German and sent under a pseudonym to Berlin 0,27, Schicklerstrasse 5, II.

DR. A. L. Coulson reported as follows on *the Perpeti Meteorite* :—

At 11 p. m. on the 14th May, 1935, a meteoric shower occurred in the vicinity of the villages of Perpeti (23° 19′ 30″ : 91° 0′ 0″), Bhateswar, and Pilgiri under the jurisdiction of the Chandina police station, and near other villages under the police stations of Kachua and Hajiganj in the Tippera district of Bengal. Eleven pieces in all were recovered. The total weight of all specimens is 21,942·57 grams ; the largest stone weighs 6,689·85 grams. The specific gravity of the meteorite is 3·554. It is being analysed by Mr. P. C. Roy. The meteorite, which has been registered as No. 298, Stone in the collections of the Geological Survey of India, has been classified provisionally as No. 14, White Chondrite (Cw) in Brezina's terminology. It has a white, rather friable mass with few, chiefly white, chondri. It will be described fully in a forthcoming paper in the *Records* of the Geological Survey of India.

The stones were exhibited with the permission of the Director, Geological Survey of India, at the monthly meeting of the Asiatic Society of Bengal held in Calcutta on August 5th, 1935.

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DR. Pabitra K. Sen, Ph.D. (Lond)., D.I.C., of the Department of Botany, Calcutta University, has been appointed, on the selection of the Public Service Commission, as the Physiological Botanist to the Imperial Council of Agricultural Research. Dr. Sen recently sailed for England for researches in Fruit Physiology. He intends to visit the centres of fruit research in the Continent, America, and South Africa, and will return to India after two years to take up the post.

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THE Junagarh State Government have sanctioned Rs. 5264 a year, in addition to Rs. 5960/- already sanctioned, to be awarded as scholarships to students of the backward classes for a specialized study in subjects like Medicine, Agriculture, Engineering, Technology etc. The students accepting the scholarships shall be required to serve the State for the first three years after their final examination, if required.

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FOLLOWING their decision to help the sericulture industry in this country by annual grants of a total sum of Rs. 100,000 during a period of five years, the Government of India has sanctioned to the Government of Bengal a grant of Rs. 11,317/- for the current year. This sum will be spent over a scheme for the production and supply of disease-free seed cocoons through the agency of rearers in the silk producing areas for industrial purposes and also over that for determining the comparative efficacy of disinfectants for the prevention of disease of silkworms.

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ACCORDING to a press report published in the *Times*, Commander Nino Del Grande, leader of the scientific expedition for the preparation of snake-bite serum, discovered near Nguruka in Tanganyika an ancient city. The Commander, however, thinks that the city is no more than five centuries old. It is four and a half miles long and one and a half miles wide, and is constructed terrace-wise on the wall of the great rift of an escarpment. The remains of some 4000 houses, each containing 3 to 4 rooms and having stone walls 4 ft. thick, are abundant. Nothing, however, about the antiquity of the site can be said until a full enquiry by the experts is made.

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ACCORDING to a newspaper report, a dolmen has been discovered by the State Archaeologist of Cochin in a cave in the Kattukampal village. Another dolmen, a few yards from the first, was also found. The second one is a rectangular cavity measuring about 6 ft. by 3 ft. with a heavy circular top-stone of 18 ft. in circumference. At the bottom of the dolmen was found a burial urn—the largest that he has seen, says the archaeologist.

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DR. Basanta Kumar Das, Professor of Zoology at the Osmania University, Hyderabad, will attend the International Zoological Congress at Lisbon, and will read a paper on certain characteristics of the Hyderabad fauna.

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IN the last B. Sc. Examination of the London University a number of Indians came out successful. Three obtained a second class pass in the upper division, nine in the lower, while one secured a second class pass by external examination. Mr. Subimal Chandra Ray came out with flying colours at the last London University L. L. B. Honours Examination. There are only five firsts in the list of the successful candidates, and he is one of them.

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IT is reported that the next Convocation Address of the Lucknow University will be delivered by Mr. Sachchidanand Sinha of Patna, and that of the Mysore University by Mr. C. Y. Chintamani, Editor of *The Leader*, Allahabad.

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THE exceedingly high rates charged of electricity by the Electric Supply Companies for consumption of current, especially that for fan and light, in this country, has been a matter of great public grievance. The rates charged bear no proportion to the cost of production and transmission on the part of the companies, and they are two to three times higher than those prevailing in other countries. In January last, in response to a motion brought forward by a

member of the Bengal Legislative Council, the Government accepted a resolution appointing a committee to go through the whole question and redress the grievances of the public in this respect. The personnel of the committee has been announced. But we must point out with due respect to its individual members that its composition can hardly inspire confidence in the public or satisfy it, for none of the members, with the possible exception of one, appears to possess any technical knowledge of the subject, which, we submit, is a *sine qua non* for the proper grasp of the situation. As the matter is *sub judice*, we do not express our opinion, but in a future issue, we shall go into the details of the question.

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THE Damodar has once again after an interval of 22 years burst its embankments and caused untold miseries in Western Bengal. The river problem in Western Bengal is a chronic one. It will be dealt with in the subsequent issues of the SCIENCE AND CULTURE in detail by Mr. S. C. Majumdar of the Irrigation Department of Bengal. A faulty alignment of the railway is mainly responsible for such disasters, as has been repeatedly pointed out by experts. The railways were opened in 1856, and Burdwan's tales of sorrows began from that date. The last flood which occurred on Aug. 8, 1913, was characterized by the conspicuous services of relief parties organized by the people of Calcutta, and we hope that this time too, the public response will be equally whole-hearted and large.

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REPLYING jointly to the addresses presented to him on Aug. 12 last by the Rajshahi Municipality, District Board, and the Mohammedan Association, His Excellency the Governor of Bengal dealt with the problem of water-hyacinth among other things, and said *inter alia* "The problem of water hyacinth is one of great complexity and difficulty and it must be recognized that no government in any country where this pest has once become serious has yet succeeded in dealing with it." He, however, felt that "if the people of any district so choose water hyacinth can by organization, and vigilance be kept within a reasonable distance." He, therefore, thought that "Bengal must become reconciled to the prospect of having to wage war against water-hyacinth year after year, though each year should make the task easier." In his Pabna address, His Excellency spoke somewhat in the same strain. We are glad that the problem of water-hyacinth, which is a regular curse to certain portions of Bengal and is so acute, has attracted the attention of His Excellency. United and concentrated effort by the scientists and the public, supported and backed by the Government will, however, be necessary before this complex problem can be adequately tackled.

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THE following is an abstract of the account of the Great Quetta Earthquake prepared for the press by Mr. W. D. West of the Geological Survey of India and published with the sanction of the Director. There is some discrepancy in the location of the epicentre as given by Dr. S. N. Sen (reproduced in the SCIENCE AND CULTURE of July) and by Dr. West. The geological location is certainly the correct one as it is deduced from observations on the spot. The Alipore estimates were obtained from seismograph records in which, the place of occurrence being at a distance of nearly fifteen hundred miles, the instrumental errors are likely to be magnified. As we remarked in our July number, the geologist carries on *postmortem* examination on the spot, while the meteorologist draws his conclusion from the daily record of the pulse of the Mother Earth.

"The earthquake which devastated Quetta and the surrounding country on May 31st must rank, from the point of view of the mortality sustained, as the most disastrous earthquake that has visited India within historic times, the nearest approach to it being the Kangra earthquake of 1905 when 20,000 people perished. But from the point of view of the size of the area over which the shock was actually felt it must take a less prominent place. Though the area affected has not yet been accurately estimated it is likely to have been less than 300,000 square miles. This figure may be compared with the 1,900,000 square miles for the North Bihar earthquake last year, with the 1,625,000 square miles for the Kangra earthquake of 1905, and with the

1,750,000 square miles for the Assam earthquake of 1897."

Before the last disaster Baluchistan suffered from severe earthquakes in 1892, 1909 and twice in 1931. The present one occurred at 3-2 a.m. on May 31st. The epicentral tract is about 70 miles long and 11 miles wide and lies along a narrow belt stretching from Quetta, through Mastung, to half way between Mastung and Kalat. During the quake the ground was viciously shaken horizontally for less than half a minute. The intensity of the shock diminished rapidly away from the epicentral area and this suggests a very shallow focus possibly not more than a mile or two.

Inspite of the strong popular apprehension, it may be definitely stated that the Quetta Earthquake was not volcanic in origin and that there are no active volcanoes in any part of India. The rockfalls and dust clouds which were mistaken for smoke were not volcanic but were caused by the severe shock and after-shocks. Mr. West then discusses the origin of Baluchistan Earthquakes and the relation between the position of the epicentre and the alignment of the mountain chains and concludes by saying, "It seems clear, however, that the correct way of anticipating further earthquakes and minimizing their disastrous effects, both in Baluchistan and elsewhere in India, is to construct buildings which will withstand these severe shocks."

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Mr. N. C. Mehta, I. C. S., has been appointed Secretary, Imperial Council of Agricultural Research, Government of India, and takes over charge on Aug. 12. We offer our warm congratulations to him.

Mr. Mehta passed the I. C. S. competitive examination in 1914. He began service in Muttra and was appointed Honorary Professor of Economics, Benares Hindu University. In 1918, he was appointed secretary to Sir Louis Stewart and, in 1920, was on deputation to the Gwalior State where he worked as Director of Agricultural Banks and Cooperative Societies. During 1921-1930, he was district officer at Etah, Partabgarh and Azamgarh. In 1930-32, he was Director of Land Records and Inspector-General of Registration and also worked in addition as Director of Agriculture and of Statistics and was also a member of U. P. Legislative Council.

Mr. Mehta has specialized in problems of industry and finance and has written several well-known pioneering books on Indian painting, the most famous being *Studies in Indian Painting*.

Research Notes

Date of Mohenjo-daro Civilization

The veil of mystery which hung about Mohenjo-daro is slowly lifting at last, it seems. Already ten years ago Mr. Mackay drew attention to the occurrence of imported Indian objects in Mesopotamia. Unequivocal evidence, however, was obtained in January, 1932, in the excavations which Mr. Frankfort was directing on behalf of the Oriental Institute of the University of Chicago. The relics concerned were found in a well defined archaeological stratum at Tell-Asmer, the site of ancient Eshnunna, fifty miles to the north-east of Baghdad. The Indian origin of the finds in question is above doubt according to Mr. Frankfort, for no parallels have been found in other Mesopotamian sites. Most striking among them is a cylinder seal, the subject of which at once establishes its non-Babylonian character, not only because it is without parallel among the thousands of known seal cylinders, but also because the animals, foreign to the Babylonians were obviously cut by an artist to whom they, were familiar. Moreover, the convention in which the feet and ears of these and the folds in the elephants' skin are represented, the peculiar rendering of the ears of the rhinoceros, are details which recur identically on seals from Mohenjo-daro. But it is possible to go even further : certain peculiarities of style connect the seal as definitely with the Indus civilization as if it had actually borne signs of the Indus script.

Mr. Frankfort concludes that there can be no doubt but that we have in our cylinder seal from Tell-Asmer an importation from the Indus Valley which reached Eshnunna about 2500 B. C. Nor is it a solitary example. For the more common Indian seal form, a square stamp seal with a pierced knob on the back, bearing a design of concentric squares, was also found in Tell-Asmer, and this does not seem to occur anywhere else in Mesopotamia, although known on similar seals at Mohenjo-daro.

Batakrishna Ghosh.

Bhagavadgita in Java

Mr. J. Gonda of Utrecht has won the gratitude of all Indians by publishing a short account of the Javanese version of the Bhagavadgita in the *Tijdschrift voor indische Taal-, Land- en Volkenkunde*, 1935. The Javanese Bhagavadgita, as also the Javanese Mahabharata, dates from about the year 1000 A. D. From it we, therefore, get a glimpse of what the Gita was like a thousand years ago, though, it has to be noted, the translation is by no means a literal one. Usually the Javanese author quotes the Sanskrit text (never in toto) and then adjoins a Javanese paraphrase which often contains much more than corresponding Sanskrit text which it elucidates. This procedure shows clearly that the author of the Javanese translation knew much more of the Sanskrit text than he has actually quoted. He has given those parts of the subject matter only which he considered to be most important. In a number of places his quotations and his "translations" differ from the vulgate text. It is a remarkable fact that some of these differences agree with the Kashmir recension. Many portions of the Gita declared to be interpolated by Garbe and Schrader, who have done most to reconstruct the original Gita, are found in this Javanese version. It is well-known that many Gita passages quoted by Alberuni cannot be found in the texts known to us. But Mr. Gonda has shown that at least some of these mysterious quotations may be traced in the Javanese version of the Bhagavadgita.

Mr. Gonda has definitely proved that the Javanese Mahabharata may render great help in reconstructing the Great Epic of India, and it is hoped that Prof. Sukthankar in preparing this great critical edition will pay due attention to it.

Batakrishna Ghosh.

Latest Colorimetric Method of Estimating Aluminium in Plants

This method proposed by P. Meunier *(Compt.*

rend. *199*, 1250, 1934) is based on the measurement of opacity produced by aluminium salts with cupferron. The optimum pH is between 2.5 and 4.5 and the concentration of H_3PO_4 must be less than $\frac{N}{100}$.

At $pH > 2$ Fe^{+++}, Cu^{++}, and Ti^{++++} are precipitated as cupferronates and removed by shaking with $CHCl_3$. The pH is then adjusted between 2.5-4.5 and the opacity compared with that of standard aluminium salts by Ferry spectrophotometer or photoelectric colorimeter.

This method has the advantage over the other colorimetric method, namely, the one based on the lake-formation with ammonium aurintricarboxylate (Aluminon) in presence of Am_2CO_3 at pH 7, in that it is more rapid requiring only 0.5 to 1 g of plant materials and no blank corrections are necessary.

Accuracy is the same as that of the gravimetric method of weighing aluminium as $AlPO_4$ which, however, requires 25 to 100 gms of dry plant materials.

P. B. S.

A New determination of *e*

The divergence between the values of the fundamental electronic charge e as determined from Millikan's oil-drop experiment and from the measurement of X-ray wavelengths by Bearden and others is well-known. Although both the determinations are claimed to be correct within less than 0·3%, the X-ray method leads to a value of $e = 4·825.10^{-10}$ (Bearden), $(4·793 \pm ·015).10^{-10}$ *e.s.u.* (Bäcklin) which is decidedly higher than Millikan's value $e = (4·774 \pm 0·005).10^{-10}$ *e.s.u.* Recently works are being carried on in the Physical Laboratory of Upsala to make accurate estimate of e from the determination of de Broglie wavelength of the electron from experiments on electron diffraction. Cathode rays from a hot filament are accelerated by 15-30 *KV* from a high-tension set provided with special electric valve circuit device for smoothing the fluctuations in in-put and out-put, and a tension regulating device of standard cells. Voltage from this source is fairly steady and can be accurately known within 0·01%. The cathode rays are diffracted by an etched galena crystal of known lattice. The cross grating diffraction pattern obtained by this arrangement consists of sharp spectral lines of different orders permitting the calculation of de Broglie wavelength with an error of less than 0·1%.

Since the electron-velocity is known in terms of the applied voltage and the electronic charge, the latter can be expressed in terms of λ, v, m, h and e/m. Preliminary measurements reported by Friesen (*Nature*, June 22, 1035, 1935) give $e = (4·796 \pm 0·01)$ 10^{-10} *e.s.u.* which is more in conformity with the X-ray values, and much higher than the value of Millikan.

It may be recalled again that Bond made an estimation of $e = (4·779 \pm ·0017).10^{-10}$ *e.s.u.* Starting from Eddington's relation, $hc/2\pi e^2 = 137$. The value of this factor corresponding to the new determination of e becomes 135·61. One can point out, however, that the determination of e from the electron-diffraction method depends upon the value of e/m_0 regarding which there is still some uncertainty, the spectroscopic value being always found to be slightly lower than that obtained from the discharge tube method. But as e/m_0 occurs in the power of $\frac{1}{4}$ in the expression for e, the discrepancy due to this uncertainty must be very small.

N. K. Saha.

Heat of Dissociation of Nitrogen

There has been in recent years a great deal of uncertainty regarding the heat of dissociation of the nitrogen molecule into two normal atoms. All values ranging from 19 volts to 6·5 have been given by different investigators proceeding from different points of view. The tendency in recent years has been for a lower value. The most recent contributors to the subject are Herzberg and Sponer who, proceeding from a study of predissociation observed in band spectra, derive a value of $7·34 \pm 0·02$ volts, corresponding to a heat of dissociation of 169·3 K cal. The predissociation in the first and second positive bands has been known from a long time and recently Coster and his pupils, and Herzberg and others carried out exact determination. The values obtained were 12·07 volts for the second positive band, and 9·79 volts for the first positive band. As the difference 2·28 volts corresponds to the

observed difference in energy value of the normal $^4S_2$ and the excited ^2D-level of nitrogen, they concluded that the molecular state of the first positive band is formed by a normal $^4S_2$ and an excited ^2D-atom, and that of the second positive band is formed by two excited ^2D-atoms. From this the heat of dissociation comes to be 7·34 volts.

It may be mentioned that though the predissociation limits of the two bands are well-known, the energy values could not be accurately determined because the bands belong to the triplet system given by an excited molecule. The initial energy of excitation of the first triplet level was unknown. This has been rendered possible by the discovery of intercombination bands at about λ 2200 by Vegard in Norway and Kaplan in America. The discovery gives the excitation potential of the triplet system to be 6·14 volts.

Though this value does not agree with a obtained from ionization potential measurements, it appears hat the value is correct, and the heat of dissociation of nitrogen has after all been correctly determined.

The work represents a very fine case of determination of very important chemical data from purely physical experiments, which was almost impossible from chemical methods, and illustrates how spectroscopy is being increasingly applied to the service of chemistry.

M. N. S.

Ionospheric Measurement

In a letter in *Nature* of June 8, 1935, Prof. S. K. Mitra and Mr. P. Syam announce that they have been able to detect echoes of radio waves returned from a height of only 55 Km. The significance of this announcement will be made clear if one considers the structure which the ionosphere is usually believed to possess.

The ionosphere extends from a height of about 90 Km. above the surface of the earth to a height which, though not well defined, is believed to extend beyond 500 to 600 Km. The region between the upper and the lower boundary is not uniformly ionized. There are two main regions which are much more intensely ionized than the others. The upper one known as F or Appleton region is situated at about a height of 250 Km. and the lower one, the E or the Heaviside region at a height of about 90 to 100 Km. The observations of Mitra and Syam prove that during daytime another intensely ionized region of ionosphere is formed below the E region. At such height the air pressure is comparatively large, and the region is strongly absorbing of radio waves owing to increased collision between the electrons or ions and the neutral gas molecules. As a result, Mitra and Syam have found that waves below a certain frequency fail to give echoes from the E layer as they are absorbed during their passage through this region.

It may be mentioned that the possibilities of the existence of a low-lying absorbing layer, called D layer, had sometimes been suggested by other workers. But the tendency in recent years has been to discredit its existence. If Mitra and Syam's observations are corroborated, the ionosphere will be regarded as beginning at day-t from a much l height than is supposed to be at present, and to consist of three main regions of ionization D, E, and F at heights of 55, 90, and 250 Km. respectively.

Craniological Study of Metopism

In *L' Anthropologie*, *45*, Nos. 3-4, is published an article by Prof. Chevket Aziz Kansu of Istanbul, on the Craniological study of metopism (contribution à l' étude Craniologique du Métopisme). Here are the author's conclusions which are, however, based on the examination of 50 crania with metopic suture and 50 non-metopic, preserved in the Anthropological Laboratory of the University of Istanbul. (1) There is a close relation between brachycephaly and metopism. The more will the skull be hyper-brachycephalic, the more will there be the frequency of occurrence of metopism. Moreover, as brachycephalization is "a progressive stage in our evolution," metopism, our author tends to suggest, is "a character closely connected with the evolutive factor of the human species" and is "dominant in the Mendelian sense of the term." (2) Though there is no marked difference between the two groups under examination as regards the temporal surface, the facial and nasal surfaces are found to be a little greater in the metopic crania than the other. (3)

The area of the external surface of the base of the skull and the surface of the lamina cribrosa is greater in metopic than the other. (4) The cranial capacity, calculated according to the classical formula, is also a little greater in the metopic than the other. (In taking the length of cranium the author has discarded Glabella and has adopted, according to Papillant, the antero-posterior metopic diameter. (5) The capacity of maxillary sinus and sella turcica is again greater in metopic than the other. (6) The degree of protuberance of nasal spine and inion is a little greater in metopic crania than the other, while glabella is less prominent. Added to these are the high frequency of Wormian bones and the extreme complication of sutures in the metopic crania. Finally, in the opinion of the author, a radiological investigation on the living will be of great importance in identifying the metopic individuals, so that the anthropologists will be able to study their anthropometry, their morphological types and to submit them to psychological tests, which may reveal interesting and hitherto unknown facts concerning the problem in question.

J. K. Gan.

Molasses as Fertilizers

In recent publications on fixation of atmospheric nitrogen in the soil (*Proc. Acad. Sci. U. P. 4*, 175, 1934; *ibid 4*, 330, 1935) N. R. Dhar and S. K. Mukerji obtained the following interesting results:

When canesugar is added to sterilized and unsterilized soils and exposed to light and air, there is appreciable increase in the ammoniacal nitrogen content; with unsterilized soil the ammoniacal nitrogen is nine times greater than that originally present in the soil. The amount of ammonia in presence of light is always greater than that in the dark.

By the addition of molasses to soils which have been properly aerated the ammoniacal nitrogen also increases; in this case the ammoniacal nitrogen is three times greater than that originally present in he soil, when 3600 Kgm of molasses are added per acre of land. When the aeration of the soil is insufficient the increase of ammonia is less and the soil becomes acidic.

Under completely sterilized conditions when canesugar is mixed with soil and exposed to sunlight, there is also an increase in the ammoniacal nitrogen. The total available nitrogen (ammoniacal and nitric) in the soil was 0·005%, but after an exposure to sunlight in a quartz flask with canesugar it became 0·0098% the ammoniacal nitrogen rose from 0·00155% to 0·0056% on exposure to sunlight. It seems established, therefore, that, just as bacteria can fix nitrogen in the soil in presence of energy-rich compounds, similarly even in the absence of bacteria the photo-oxidation of the energy-rich compounds leads to the fixation of nitrogen.

When air freed from bacteria and oxides of nitrogen and ammonia is passed through a solution of glucose or canesugar mixed with freshly precipitated ferrous hydroxide, appreciable amounts of ammonia are formed.

It appears, therefore, that nitrogen fixation can take place in the complete absence of bacteria provided energy is available from the photochemical or induced oxidation of sugars.

When molasses are mixed with unsterilized soil and exposed to sunlight the ammonia content goes on increasing with the exposure up to a limiting value.

Molasses have been used as manure in increasing the yield of sugarcane to the extent of 36%. Rice cultivation is also improved by the addition of molasses to the soil.

It appears, therefore, that in tropical countries, in ordinary soils, the fixation of atmospheric nitrogen by the addition of energy-rich compounds is partially bacterial and partially photochemical. The oxidation of energy-rich organic compounds by air, either by induction or light absorption, or by bacterial action, causes the fixation of atmospheric nitrogen in the soil.

University and Academy News

Biochemical Society, Calcutta

In the Annual General Meeting of the Biochemical Society, Calcutta, held at the All-India Institute of Hygiene on July 11, the annual report of the Secretary and Treasurer was presented by the Secretary, Dr. B. C. Guha. In course of the report,, the Secretary said 'The Biochemical Society, Calcutta, was inaugurated in a meeting held at the All-India Institute of Hygiene on July 5, 1934. The need of such a society for the promotion of biochemical studies and research had been felt for sometime and it was hoped that the creation of such a scientific body in Calcutta would evoke local response. In this expectation the promoters of the Society have been fully justified. The record of last year's work shows good progress and stimulates hope for the future.'

Since the inauguration of the Society in July, 1934, ten meetings have been held in which the following fourteen papers have been read and discussed. The papers display a wide range of interests.

1. B. Ahmad—The Metabolism of Carotene.
2. A. C. Roy—Cultivation of micro-organisms on vegetable media
3. S. C. Banerjee and H. K. Sen—Catalytic activation of diastase.
4. R. C. Bhattacharjee—The therapeutic applications of snake venom.
5. A. R. Ghosh and B. C. Guha—Vitamin C in Indian food-stuffs.
6. B. Ahmad The excretion of Vitamin C in human urine.
7. P. C. Mitter and N. N. Chatterjee—The formation of purines from iminazoles.
8. B. N. Ghosh—The combination of antigens with anti-bodies.
9. N. R. Chatterjee, D. N. Chatterjee, Pasricha and S. Ghosh—Effect of bacteriophage on the enzyme activity of vibrio cholerae.
10. A. C. Roy—Biochemistry of snake venom.
11. J. S. Chowhan—Therapeutic uses of snake venom.
12. B. C. Guha and H. G. Biswas—Flavines and Vitamin B_2.
13. B. C. Guha and A. R. Ghosh—The biological synthesis of ascorbic acid.
14. H. E. C. Wilson and S. L. Mukherjee—Some observations on the composition of the urine in relation to calculus formation.

At the annual meeting the following papers were read :

1. N. Das and B. C. Guha—The respiration of *Bact. Staphylococcus*
2. A. R. Ghosh and B. C. Guha—The relation between dietary composition and the urinary excretion of ascorbic acid.

For the next year the following have been elected to form the Committee :

Mr. N. M. Basu, Dr. P. K. Bose, Dr. P. De, Dr. J. N. Mukherjee, Dr. S. N. Ray, Mr. A. C. Roy, Dr. B. B. Sen and Dr. H. E. C. Wilson. Dr. S. Ghosh and Dr. B. C. Guha have been elected Hony. Secretaries and Dr. B. Ahmad Hony. Treasurer.

The Academy of Sciences, U. P.

An extraordinary monthly meeting of the Academy of Sciences of the United Provinces of Agra and Oudh was held on Friday, May 10, 1935, at 6. P. M. In the absence of the President, Prof. A. C. Banerji, Vice-President, was voted to the Chair.

The following papers were read and discussed:

1. R. N. Ghosh and L. P. Verma, Physics Deptt., Allahabad University : On the application of Heaviside's method to the problem of vibrations of Pianoforte string.
2. Har Dayal Srivastava, Zoology Deptt., Allahabad University: New Amphistomatous Parasites from an Indian Fresh-water Fish.
3. Hrishikesha Trivedi, Physics Deptt., Allahabad University: The absorption spectra of the vapour of oxides of copper, iron, nickel and cobalt and the determination of their heats of sublimation.

4. **Hrishikesha Trivedi**, Physics Deptt., Allahabad University: The absorption spectra of the vapour of the monosulphides of iron, nickel, cobalt, copper and tin and the determination of their heats of sublimation.

The ordinary monthly meeting of the Academy of Sciences of the United Provinces of Agra and Oudh was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad, on the 27th of July, 1935, at 4 P.M.

The following papers were read and discussed, Prof. N. R. Dhar, President of the Academy, being in the Chair:

1. Radha Raman Agarwal and Shikhibhushan Dutt, Chemistry Department, Allahabad University: The Chemical Examination of the fruits of Lagenaria Vulgaris Seringe (bitter variety). Part I.—The constituents of the oil from the seeds.
2. Mohit Kumar Mukerjee and Shikhibhushan Dutt, Chemistry Department, Allahabad University: Colour and constitution of Dyestuffs derived from Fluorenone.
3. H. R Mehra, Zoology Department, Allahabad University: New Trematodes of the family Lecithodendriidae Odhner, 1911, with a discussion on the classification of the family.
4. S C. Verma, Zoology Department, Allahabad University: Preliminary account of new trematodes with Ani.
5. Jagraj Behari Lal, Chemistry Department, Allahabad University: A note on the colouring matter of the flowers of Lantana Camera, Linn.

The Indore Meeting of the Indian Science Congress

Arrangements are now actively in hand for the forthcoming meeting of the Indian Science Congress Association in Indore. As usual, the date of the meeting is from the 2nd to the 8th of January, 1935, thus enabling members to avail themselves of the Christmas concession on the railways. In addition, the railway authorities have been approached with regard to granting further concessions, but their decision in the matter will not be known until after the Railway Association has met at Simla in October.

The meeting is being held under the patronage of H. H. Maharajadhiraj Raj Rajeshwar Sawai Shree Yeshwant Rao Holkar Bahadur, Maharaja of Indore. In accordance with the alteration which was made last year in regard to the President's term of office, Dr. J. H. Hutton will remain President of the Association until he hands over his office at the Inaugural Meeting to the President-Elect, who is Rai Sir Upendranath Brahmachari, Bahadur, Kt., M.A., M.D., Ph.D., F.S.M.F., F.A.S.B.

At the last meeting of the Congress, held in Calcutta, two alterations were made in the list of Sections. The name of the Geology Section was changed to "Geology and Geography", thus indicating that papers on geography would be accepted; while a new section for Physiology was added, thus bringing the number of sections up to 10.

The names and addresses of the Sectional Presidents are as follows: —

1. Mathematics and Physics	..	Dr. T. Royds, D.Sc., Director, Kodaikanal Observatory, Kodaikanal, S. India.
2. Chemistry	..	Dr. P. C. Guha, D.Sc., Professor of Organic Chemistry, Indian Institute of Science, Bangalore.
3. Geology and Geography	..	B. Rama Rao, Esq., M.A., Mysore Geological Department, Bangalore.
4. Botany	..	Dr. S. R. Bose, D. Sc, F.R.S.E., F. L. S., Professor of Botany, Carmichael Medical College, Belgachia, Calcutta.
5. Zoology	..	Dr. H. K. Mukherjee, D.Sc., D.I.C., University Professor and Head of the Department of Zoology, Calcutta University, 35, Ballygunge Circular Road, Calcutta.
6. Anthropology	..	H. C. Chakladar Esq., M.A., Lecturer in Anthropology, Calcutta University, 28-4, Srimohan Lane, Kalighat, Calcutta.
Agriculture	..	Mr. A. K. Yagna Narayan Aier, M.A., Dip. in Agri. (Cantab.) N.D.D., F.C.S., (Retired Director of Agriculture, Sankarapuram, Bangalore.
Medical and Veterinary Research	..	Lt.-Col. H. E. Shortt, I.M.S.

		Director, King Institute, Guindy, Madras.
9. Physiology	..	Dr. W. Burridge, D. M., M. A. (Oxon), Professor of Physiology, Lucknow University.
10. Psychology	..	J. M. Sen, Esq., M. Ed. (Leeds), B.Sc. (Cal.), F.R.G.S., Inspector of Schools, Presidency Division, Bengal, 63 Lansdowne Road, Calcutta.

Papers should be submitted to the Sectional Presidents concerned by the 15th of September. A little extra time will be allowed to contributors in the Punjab.

One of the primary purposes of the Association is to encourage scientific work in different parts of India. This year it is meeting in Indore for the first time, and it is hoped that a large number of members will attend and help to stimulate scientific research in that part of India.

Indore, in addition to being fairly centrally situated for scientists from Western and North-western India, offers many attractions both in the city itself and in its immediate neighbourhood. Owing its origin to the great movement for Maratha imperialist expansion of the 18th century, Indore at present enjoys the premier position among the states included in the Central India Agency.

The City of Indore is situated 1,738 feet above the sea level and has a delightful climate and moderate rainfall. It ranks amongst the great industrial towns of India, having flourishing cotton-mills and an expanding population now estimated at about 1,50,000 people. It is an important educational centre, containing two first-grade colleges (one of which is maintained by the State), a number of high schools for boys and girls and other institutions. In the Civil Area are situated the Daly College (an institution for the sons of Chiefs), which is a fine building of white marble, the Plant Institute, and a Medical School. Indore also contains many places and buildings worth seeing. A few miles from the city is Badarkha, where up-to-date water works (with the largest siphon system in the world) are nearing completion.

About 60 miles from Indore and situated in Dhar State is Mandu, a favourite haunt of tourists and students of India's past history. Once the proud capital of the independent Muslim kingdom of Malwa and a fort of unparalleled natural strength, it now contains extensive ruins of mosques, palaces and other buildings of great architectural merit. Not far off from it is Bagh (in Gwalior State), which is famous for its rockcut caves of great antiquity. About forty miles to the south of Indore is Mandhata, an island of superb natural beauty in the Nerbudda river, the early capital of Indore State, which contains a palace and a marble statue of the saintly Ahalya Bai, one of the most illustrious rulers of the State and of India. Not very far off from Indore and easily connected by railway are Ujjain, one of the most ancient and sacred cities of India, Sanchi (in Bhopal State) with its famous stupa supposed to date from the time of the Great Asoka, Chitore the most historic place in Rajputana, and the world-celebrated Ajanta caves.

The Local Secretaries will be Dr. S. S. Deshpande, Vice-Principal and Professor of Chemistry, Holkar College, Indore, and Mr. K. A. Patwardhan, Daly College, Indore, to whom all enquiries as to accommodation should be addressed. It is particularly requested that very early intimation of the accommodation required should be sent to the Local Secretaries. *W. D. West.*

National Institute of Sciences

In a meeting of the National Institute of Sciences of India held on Saturday the 24th August, the following papers were read:

The Role of Electrical Charge in the Phagocytosis of Red Cells in Malaria, by Lt.-Col. R. N. Chopra, C.I.E., I.M.S., Mr. S. N. Mukherjee, and Dr. K. V. Krishnan; "Nappe Structure in the Archaean Rocks of the Central Provinces, by Mr. W. D. West, Geological Survey of India; Loss of Morphine in Indian Opium on Storage, by Dr. H. B. Dunnicliff, Dr. J. N. Ray and Mr. Gurcharan Singh.

As published in the August issue of Science and Culture a symposium on problems of the Ionosphere was held under the auspices of the National Institute of Sciences.

Letters to the Editor

On estimating individual Yields in the case of mixed up Yields of two or more Plots in Agricultural Experiments

In agricultural experiments of the modern randomized and replicated type some times the yields of particular plots are accidentally missing. F. E. Allan and J. Wishart[1] (1930) discussed this problem for the case of a single missing plot. F. Yates[2] (1933) gave a general solution for any number of missing plots.

Instead of missing yields, it sometimes happens that the yields of two or more plots are accidentally mixed up during harvest or subsequent operations. The reconstruction and analysis of the separate yields of the mixed up plots have not been discussed so far. A general solution using the Fisherian principle of minimizing the residual variance has been worked out and found adequate by tests on actual data. Full details of the solution will be published elsewhere, but a few important results are given below for immediate reference and use by agriculturists.

(1) **Orthogonal f-fold complex design :** Let $a, b, c, \ldots f$ be the number of units in the 1st, 2nd....fth factor, so that the total number of observations available$=N = a.\, b.\, c \ldots\ldots f$. Also let A_1 and A_2 be the totals in the A-class involving the two mixed up plots; B_1 and B_2 the totals in the B class involving the two mixed up plots, and so on for F classes. If u is the total of the two mixed up plots, then the best estimates of the separate yields of the two plots are given by

$$\frac{u}{2} \pm \frac{a\,(A_1-A_2)+b\,(B_1-B_2)+\ldots\ldots f\,(F_1-F_2)}{2\,(N-a-b-c\ldots.-f)} \qquad (1)$$

(2) **Randomized Blocks :** ($f=2$, $b=$number of blocks, $t=$number of treatments). The formula now becomes

$$\frac{u}{2} \pm \frac{b\,(B_1-B_2)+t\,(T_1-T_2)}{2\,(bt-b-t)} \qquad \ldots\ldots\ldots(2)$$

(3) **Latin Square :** ($f=3$; $r=$ number of rows $=c=$ number of columns $=t=$ number of treatments $=n$). The best estimates are now given by

$$\frac{u}{2} \pm \frac{(R_1-R_2)+(C_1-C_2)+(T_1-T_2)}{(n-3)} \qquad \ldots.(3)$$

(4) **Double Latin Square :** ($f=4$; $r=$ number of rows $=c=$ number of columns $=2n$; $t=$ number of treatments $=n$; and $l=$ number of Latin Squares $=2$). One plot in one Latin Square is mixed up with one plot in the second Latin Square. This is of frequent occurrence. The solution is given by

$$\frac{u}{2} \pm \frac{n\,(R_1-R_2)+n\,(C_1-C_2)+\frac{1}{2}\,n\,(T_1-T_2)+(L_1-L_2)}{(n-2)\,(2n-1)} \qquad (4)$$

where $n=$ number of rows, columns or treatments in each Latin Square; R, C, T are the totals for rows, columns, and treatments involving the two mixed up plots and L_1 and L_2 are the totals for the two Latin Squares. Slight modifications are necessary when the two plots belong to the same type (row, column, or treatment).

The solution has also been extended to the case of mixed up yields of more than two plots.

The analysis can proceed on usual lines, but in using tests of significance, allowance will have to be made for the fact that the reconstructed values are estimated from the given data.

Statistical Laboratory,
Presidency College,
Calcutta.
10. 8. 1935

Subhendu Sekhar Bose.
P. C. Mahalanobis.

1. *Jour. Ag. Sc.* *20*, Part 3, 399-406, 1930.
2. *Emp. Jour. Expt. Ag.* *1*, No. 2, 129-142. 1933.

On the Exact Distribution and Moment-Coefficients of the D²-Statistics

Given a number of normal populations it is often desirable to have a numerical measure of the divergence between two samples drawn from them. For example, if we have three samples Σ_1, Σ_2, Σ_3, we should like to know whether the difference between Σ_1 and Σ_2 is significantly greater than the difference between Σ_1 and Σ_3. Professor P. C. Mahalanobis has given a generalised statistical measure of such divergence between two P-variate samples. This statistics, which he calls D^2, has proved extremely useful in biometric studies[1]. He obtained the first four moments of D^2 by approximate methods for the case of uncorrelated variates[2]. The exact distribution of D^2 and a general expression for the higher moments were not however known. I have now succeeded in obtaining these results which are given below. Fuller details will be published shortly in ***Sankhya : The Indian Journal of Statistics.***

If Δ^2 denotes the population value of D^2, and D_1^2 the uncorrected sample value of the same statistic then the kth moment of D_1^2 is given by

$$\mu'_k(D_1^2) = \Delta^{2k} \mathop{Lt}_{c \to \infty} F\left(-k, -k-\frac{P}{2}+1, c, \frac{4c}{nP\Delta^2}\right) \qquad \ldots\ldots\ldots(1)$$

where F is the well-known hypergeometric function, and n is the harmonic mean between n_1 and n_2, the number of individuals in the two samples. Since

$$\mu_1'(D_1^2) = \Delta^2 + \frac{2}{n} \qquad \ldots\ldots\ldots(2)$$

it is clear that to get rid of the bias in the mean we must put

$$D^2 = D_1^2 - \frac{2}{n} \qquad \ldots\ldots\ldots(3)$$

The first four moments of D^2 turn out to be exactly those given by Mahalanobis[2] showing that (*i*) his expressions are exact, in spite of the fact that they were obtained by approximate methods, and that (*ii*) his expressions remain valid for the case of correlated variables.

The exact distribution of D_1^2 comes out to be

$$f(D_1^2)\, d(D_1^2) = \frac{nP}{4}\left(\frac{D_1^2}{\Delta^2}\right)^{\frac{P-2}{4}} e^{-\frac{nP}{4}(D_1^2+\Delta^2)} \times I_{\frac{P-2}{2}}\left(\frac{nPD_1\Delta}{2}\right) d(D_1^2) \qquad \ldots\ldots\ldots(4)$$

where $I_n(x)$ is the well-known Bessel function with purely imaginary argument. The distribution of D^2 is obtained by substitution from (3).

In the special case when $\Delta^2 = 0$, the above distribution reduces to

$$\frac{1}{\Gamma\left(\frac{P}{2}\right)}\left(\frac{Pn}{4}\right)^{\frac{P}{2}} (D_1^2)^{\frac{P-2}{2}} e^{-\frac{nPD_1^2}{4}} d(D_1^2) \qquad \ldots\ldots(5)$$

If we put $m = \frac{P-2}{2}$, $x = \frac{nPD_1^2}{4}$, then the distribution of x can be written as:

$$\frac{1}{\Gamma(m+1)} x^m e^{-x}\, dx \qquad \ldots\ldots\ldots(6)$$

The probability of attaining any assigned value of x (when $\Delta^2 = 0$) can be obtained immediately from a table of incomplete Gamma functions. When however Δ^2 is not zero, the probability of D_1^2 attaining any given value is given by

$$\int_0^{D_1^2} f(D_1^2)\, d(D_1^2) \qquad \ldots\ldots\ldots(7)$$

where $f(D_1^2)$ is given in (4).

A table of the values of the above integral will be of great practical importance in many branches of applied statistics. We are compiling such a table by rather tedius computations in the Statistical Laboratory. I should like to draw the attention of pure mathematicians to the evaluation of this integral. A closed expression would not perhaps be forthcoming. If it does, so much the better. If not, a convergent series (preferably a rather rapidly convergent one) would do. But the same series may not be useful for computational purposes for all ranges of values of the independent variable and the parameters involved. In that case different series for different regions (confining ourselves, of course, to those regions which are of practical interest) would have to be used.

Statistical Laboratory,
Presidency College,
Calcutta, 7.7.35.

Rajchandra Bose.

1. Analysis of Race-Mixture in Bengal. *Ind. Science Congress* 1926, and *Jour. Asiat. Soc. Bengal, 23* 1927.
Statistical Study of Chinese Head. *Man in India, 8*, 1928.
2. Tests and Measures of Divergence. *J.A.S.B. 26*, 1930,4.

On a hitherto Unrecorded White-flowered *Urena* Linn

The genus *Urena* Linn., belonging to the Malvaceæ is represented by 27 species in the tropical and subtropical regions of the world[1]. Of these four listed in Flora of British India[2] are *U. lobata U. sinuata, U. repanda* and *U. rigida*. To these a fifth *U. callifera*[3] has been added, but except in a very minor character of the calyx it is identical with *U. lobata*. The first three species (and of course, the last) have pink corolla, while the fourth has the petals white. According to the same authority, the first two are distributed over the tropics of both the hemispheres, whereas the others are confined to Asia. Another white-flowered species, *U. stelipella*[4] Lem. is confined to Brazil.

The plant which forms the subject of this note is identical with *U. lobata*, except for the flower colour, the latter species having pink flowers, while this plant has white, and the flowers are also somewhat smaller on an average.

Leaving out of consideration *U. stelipella* which, besides being restricted to Brazil, differs from the others in other important respects, the classification (or the seperation) of the Indian species is based on the characters of the carpels. These are armed with hooked bristles in the first two species (and the last) named above, but are smooth and unarmed in the others.

The plant in question has *spiny carpels*, and thus resembles *U. lobata* in this character, but differs in the flower colour. It resembles *U. rigida* in the colour of the petals, but differs from it in the character of the carpels, these being smooth in the latter. Thus it resembles neither of the hitherto described Indian species completely.

The specimens of this new plant, numbering about a dozen, were found growing in a restricted area, among numerous plants of the common pink type, in the Benares Hindu University Botanical Garden, in October last. They were conspicuously absent elsewhere, although the individuals of the pink type were flourishing in other places. So far as known they were never observed before.

In order to make sure that the plant had never been collected and recorded before, specimens were taken to the Calcutta Botanical Garden for comparison. Although a thorough search was made, no specimens similar to these were found in the herbarium. It is thus confirmed that the plant is quite new to the Indian flora.

In conclusion I offer my best thanks to Mr. K. P. Biswas for helping me to compare the specimens with the types kept at the Sibpur herbarium in which these plants have now been incorporated.

Specimens of this plant have also been sent to Kew.

Botany Department,
Benares Hindu University. N. K. Tiwary.
30. 6 1935.

1. *Index Kewensis. 2,* 1149, 1895. Oxford 1886-1895. *Supplementum 1.,* 447.
Ibid 4, 243, 1906-1910.
2. Hooker: *Flora British India. 1.* 329.
3. Clarke: *Journ. Linn. Soc. 25, 71,* 1889
4. Bailey: *Standard Cyclopaedia of Horticulture. 6,* 3416, 1919.

The Presence of Tyloses in Tinospora, a frequent Climber in the Tropics.

Tyloses have been found within vessels of secondary xylem of roots, stems and petioles of *Tinospora cordifolia* Miers. and *T. tomentosa* Miers; they are mostly thin-walled unicellular structures with protoplasm, nucleus and cellulose walls, but in some cases they are multicellular also, some of the vessels being crowded with them (Fig. 1). From an examination of a number of healthy plants for about six months it seems to be a case of normal development here. Tyloses *in Tinospora* do not include starch as reserve substance.

Tyloses are usually found in angiospermic woody trees and in some Conifers either as a characteristic of some species or due to wounding. They have also been found in the vessels of a few herbs. Eames and MacDaniels[1] have reported their occurrence in climbers belonging to the

genera of *Cucurbita* and *Convolvulus*, and their presence in *Tinospora* (Family *Menispermaceæ*) seems to be unrecorded. H. S. Holden[2] has distinguished true tyloses from cavity-parenchyma occuring in the protoxylem of petioles of Ferns.

The exact function of tyloses especially in herbs is not yet known; Eames and MacDaniels think[3] that they develop due to a difference of pressure of wood-cells surrounding a vessel, but this does not seem to lead very far.

Botanical Laboratory, S. R. Bose.
Carmichael Medical College, D. N. Chakraverty.
Calcutta. 12-4-1935.

1. *Introduction to Plant-Anatomy* p. 180: 1925.
2. *Journal of the Linnean Society,* London; Sept. 1925
3. *loc. cit.* p. 181.

A Note on the theory of Viscosity of Liquid Metals

A theory of the viscosity of liquids on simple classical lines has been recently put forward by Prof. Andrade[1]. Assuming that the liquid molecules retain sufficient of the crystalline character which they had in the solid state and possess a frequency of vibration very nearly equal to the frequency in the solid state at the melting point, and on replacing this characteristic frequency in terms of the melting point by using Lindeman's semi-empirical formula, he obtains the formula

$$\eta = \frac{4}{3}c\,\frac{(AT_m)^{\frac{1}{2}}}{(NV_A)^{\frac{2}{3}}} = 5{\cdot}1 \times 10^{-4}\,\frac{(AT_m)^{\frac{1}{2}}}{V_A^{\frac{2}{3}}} \qquad \ldots (1)$$

where η is the viscosity, A is the atomic weight, N the Avogadro's number, T_m the melting point and V_A the volume of a gram-atom at the temperature T_m.

In view of the recent investigations[2] into the properties of liquid metals it may be of interest to deduce a formula for viscosity of metals in the liquid state in a slightly different form. Following Andrade, we take the liquid metal near the melting point, as still possessing the lattice structure which was characteristic of it in the solid state. The Debye or rather Einstein characteristic frequency is, of course, different in the liquid state and in fact,

$$\left(\frac{\nu_L}{\nu_S}\right)^3 = e^{-\frac{L}{kT}}$$

where L is the latent heat.

If the liquid molecules vibrate with a frequency ν we get, with Andrade, $\eta = \frac{4}{3}\frac{\nu m}{l}$ where l is the average distance between the centres of molecules. Putting $\beta l = n^{-\frac{1}{3}}$ where n is the number of molecules per unit volume and β is a constant, $\eta = \frac{4}{3}\beta\nu m n^{\frac{1}{3}}$. If ρ denotes the density, A the atomic weight and m_H the mass of the hydrogen atom, we have,

$$n = \frac{\rho}{Am_H} \text{ and } \eta = \frac{4}{3}\beta\nu\left(\frac{\rho}{A}\right)^{1/3}(Am_H)^{2/3}$$

If now, we put $h\nu = k\theta_L$ or $\nu = \frac{k}{h}\theta_L$, where k represents Baltzmann's constant, h is Planck's constant, and θ_L is the Debye characteristic temperature, we get

$$\eta = \frac{4}{3}\beta\frac{k}{h}m_H^{\frac{2}{3}}A\left(\frac{\rho}{A}\right)^{1/3}\theta_L \qquad \ldots (2)$$

The values of viscosity calculated from the above formula and the observed values of viscosity of certain liquid metals for which published experimental data exist are shown in the following table :—

Liquid metal	η cal. with $\beta = 2{\cdot}3$		η obs.
Cd	·024	>	·018
Hg	·023		·021
Cu	·032		·038
Pb	·023		·028

It will be seen from the above table that the agreement between the calculated and observed values is fair, considering the large discrepancies between the values of viscosities obtained by different observers and also the approximate nature of the theory. According to Andrade's formula the agreement between theory and experiment for the four liquid metals Hg, Pb, Sn, and Cu is, no doubt, very satisfactory; but this is to a certain extent a chance coincidence. As Andrade himself observes, "No great emphasis is placed by the writer on the surprising closeness of the agreement for the four metals, which is within 10 per cent. or less, for this agreement depends upon the exact value given to the constant in formula (1)." In formula (2) the agreement depends upon the value of the constant β and upon the crystal structure of the metal.

Again, it is more usual and theoretically better to express the characteristic frequency in terms of the Debye temperature θ_L as we have done in (2) and not in terms of the melting point, as in (1). In this we are also following Mott's recent use in his paper[3] on the resistance of liquid metals.

Baroda College, Gujrat. 23. 7. 35. D. V. Gogate.

1. *Phil. Mag.*, *17*, 497, 1934.
2. *Proc. Roy. Soc.*, *146*, 465. 1934.
3. *loc. cit.*

The Spectrum of Zinc in the Region, λ 2800-400 A. U.

The spectrum of zinc has been investigated from λ 2800 to 400 A. U. The lines corresponding to different stages of ionization have been distinguished from one another by introducing inductance in the spark circuit. The experimental part of the investigation was carried out partly in London in Prof. Fowler's laboratory, and partly at Upsala, Sweden, in Prof. Siegbahn's laboratory. At Upsala the spectra were excited by condensed "hot sparks", and the photographs were taken by means of two "grazing incidence" spectrographs. The photographs obtained were extremely good as regards both definition and resolution of the lines. The observational material is exhaustive for the region examined; the determinations of wave-lengths and intensities are of a very high degree of accuracy.

The spectra consists of about 700 lines belonging to Zn IV, about 250 lines to Zn III, and about 60 lines to Zn II spectrum. It has been thought necessary, before proceeding with the analysis of the complex Zn IV spectrum, to account for the new Zn III and Zn II lines obtained. The structure of the Zn II spectrum is fairly well-known, but only a small part of the Zn III spectrum has been classified. With the

help of the material obtained, it has been possible to extend very considerably the knowledge of the structure of the spectra. In addition to the seventeen terms belonging to the configurations $3d^{10}$, $3d^{9}4s$ and $3d^{9}4p$, and identified by Laporte and Lang[1], it has been possible to classify about 180 new lines identifying 53 new terms arising out of the configurations, $3d^{9}$ $5s$, $3d^{9}$ $4d$ and $3d^{8}4s4p$ of the Zn III atoms. The characteristic differences of $3d^{9}$ $5s$ ^{3}D terms are 462 and 2322 cm^{-1}. Recently Bloch[2] has published a catalogue of Zn III lines in the region λ5800-2100 A. U. Some characteristic differences in this group of lines also have been obtained in the course of the present investigation.

For the spectrum of Zn II, 26 new terms have been established, of which 16 arise from the configuration $3d^{9}4s$-$4p$, and the remaining 10 are undesignated. These new terms together with the terms already known, have enabled the writer to assign classifications to 53 Zn II lines in addition to those previously known.

Full accounts of these works will be published soon in th *Transactions of the Bose Research Institute.*

Bose Research Institute, K. C. Mazumdar.
Calcutta, 6.7.35.

1. *Phy. Rev. 30*, 378, 1927.
2. *Jour. de Physique*, July 1934.

Are Carbohydrates a constituent part of Lignin ?

In the earlier stages of the investigation on lignin, it was customary to define it as the non-poly-saccharidic portion of the cell wall. In their well-known monograph[1] Cross and Bevan term the non-cellulosic part as the incrusting matter or lignin. Hägglund appears to be the first to obtain a pentose (arabinose) by boiling Willstätter-lignin (prepared from spruce-wood by his modification of the HCl method) with 3% HCl[2].

It was reported by some investigators that furfural was present in the distillate when lignin was distilled with 12% HCl. These observations led to the hypothesis propounded by Hägglund that pentoses or furfural-yielding bodies are part and parcel of lignin. Schmidt[3] has defined lignin as the compound of an aromatic body with not only pentosans but also hexosans. During delignification with ClO_2 these sugars are removed along with lignin. According to Schmidt, Geissler and Ardnt[4] HCl-lignin which is apparently pentosan-free, gives a water-soluble pentosan by ClO_2 treatment. Pringsheim in his treatise on polysaccharides (p. 101 1923), strongly supports Schmidt.

HCl-lignin from jute prepared in the ordinary way gave traces of furfural (aniline acetate test) on distillation with 12% HCl. But the lignin prepared according to the modified method of the author[5] gave no trace of it. Lignin thus obtained is a spongy mass, and as such, it tenaciously retains a fraction of the sugars by absorption, which can only be removed by prolonged boiling with water under reflux for 2—3 days. It is worth while to mention that lignins similarly prepared from bamboo and cocoanut fibre were found absolutely free from furfural-yielding complexes. This fact shows that pectin matter (which gives furfural under these circumstances) present in jute has been completely hydrolyzed by HCl and cannot, therefore, interfere with the estimation of lignin or its isolation in the pure state. Nor can hemi-celluloses (which also give furfural under similar conditions) of jute in any way vitiate the results. Absence of undissolved cellulose in the separated lignin has been conclusively shown by the dissolution of the latter by ClO_2. Moreover, when purified lignin was boiled with dilute sulphuric acid under reflux and filtered, the filtrate reduced Fehling's solution not because it contained sugars (the solution was optically inactive) but owing to the presence of formaldehyde (which gave characteristic dimedone derivative) split off from the dioxymethylene group present in lignin[6].

Hägglund's hypothesis has been severely criticized by many workers particularly by Heuser[7], who has pointed out that the presence of pentosans in lignin preparation is due to the incomplete hydrolysis of the lignified plant material. The present author holds that even if the hydrolysis be complete their presence in lignin may as well be due to imperfect purification of the latter, as has been found in the case of jute-lignin.

Further evidence in support of the veiw that pentosans or pentoses are no part of the structural arrangement of the lignin molecule is available from the fact that when allowance is made for the insoluble phloroglucide of formaldehyde obtained by the distillation of ligno-celluloses in the usual method of estimation of pentosans, the discrepancy between the furfural values of raw and delignified samples practically disappears as has been found in the case of jute, bamboo and cocoanut fibre. This indirectly shows that lignin should give no furfural, and none is actually obtained.

The new definition of incrusting matter (*i.e.* lignin) by Schmidt[8] has not been accepted by investigators on lignin in general. Heuser[9] criticized it adversely on plausible grounds, Fuchs and Honsig[10] also held similar views. The ultra-violet absorption spectra of lignin and its derivatives by Herzog and Hillmer[11] indicate that lignin is composed of benzene rings with a side-chain of 3 carbon atoms, which is saturated. It is, therefore, in disagreement with Schmidt's view regarding the composition of lignin. Then again, the degradation products of lignin have been studied by many workers but except Rassow and Linde [12] who obtained galactose by the oxidation of bamboo-lignin with nitric acid, none could detect any pentose or hexose in the course of the investigation on lignin. The author repeated the

experiment of Rassow and Linde with jute-lignin but failed to confirm their result. In view of these facts, it appears highly improbable that sugars are component parts of lignin and neither the hypothesis of Hägglund nor that of Schmidt can, therefore, hold good, at least in the case of jute, bamboo and cocoanut fibre lignins.

Chemistry Laboratory,
The University,
Dacca, 20-7-35.
Pulin Behari Sarkar.

1. *Cellulose* 93—94, 1918.
2. *Ber.* *56*, 1866, 1923.
3. *Ber.* *58*, 1394, 1925.
4. *Ber.* *56*, 23, 1923.
5. *J. Indian Chem. Soc.* *11*, 691, 1934.
6. *Ibid* ,, ,, ,,
7. *Cellulose Chemie*, *4*, 77, 84, 1923.
8. *loc. cit.*
9. *Ber.* *59*, 598, 1926.
10. *Ber.* *59*, 2850, 1926.
11. *Ber.* *60*, 365, 1927; *ibid.* *64*, 1288, 1931
Z. Physiol Chem., *168*, 117, 1927;
Papier-Fabr., *30*, 205, 1932.
12. *Z. angew. Chem.* *44*, 831, 1931.

On the Triple Nitrites of the Rare Earths and a New Convenient Microtest for Caesium

Ball and Abram[1] prepared a number of complex bismuthinitrites of the types $X_3Bi(NO_2)_6$ and $X_2YBi(NO_2)_6$ where X stands for NH_4, K, Rb, Cs, Tl and Y for Li, Na or Ag. The classical researches of Professor Urbain on the use of bismuth as an "e'le'ment Se'parateur" is based on the isomorphic relationship of bismuth nitrate and double nitrate with the corresponding salts of the rare earths. This led us to the study of the triple nitrites of rare earths hitherto unknown. A series of salts of the type $NaCs_2R(NO_2)_6$ have been prepared where R = La, Ce, Pr, Nd, Sm, Eu, and Gd. They form beautiful octahedral crystals, stable at the ordinary temperature and sparingly soluble in water in which they are slowly hydrolyzed. The rare earths of the yttrium group do not form such compounds.

Of these triple nitrites, the praseodymium salt is very suitable for the micro-detection of caesium. When to a drop of a solution of $NaNO_2$ (10%) and praseodymium nitrate (3%) a drop of caesium solution up to the order of 4×10^{-8} gm. is added and kept for 3 or 4 minutes, beautiful octahedral crystals are obtained. These are specific for caesium. Rubidium does not interfere. The sensibility limit is 0·04 γ. La, Ce, etc. can also be used for praseodymium. This test appears to be more sensitive than the Cs-Ag-Au-chloride test advocated by Professor Emich for the micro-chemical identification of caesium.

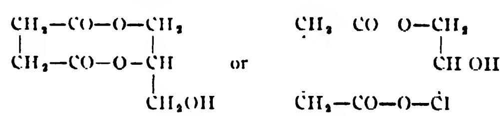
Chemistry Department,
University College of Science,
Calcutta, 27-7-35.
P. B. Sarkar.
H. C. Goswami.

1. *J. Chem. Soc.* *103*, 2110, 1913.

Syntheses of Ring Glycerides of dibasic Acids

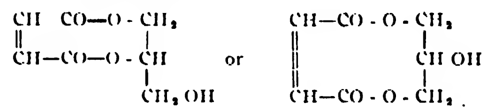
No attempt has yet been made to prepare glycerides of dibasic acids. Anticipating that such may exist in nature in seeds of fruits in which dibasic acids are present, the present investigations were begun. As a result of various attempts the following glycerides have been synthesized; they may be αα or αβ :—

1. From succinic acid



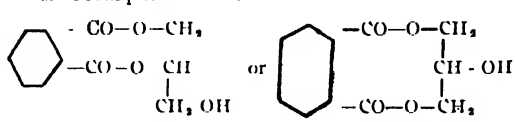
αβ- succinin αα-succinin

2. From maleic acid



αβ- malein αα- malein

3. From phthalic acid



αβ- phthalin αα- phthalin

The positions have not yet been determined. They have been prepared by heating the respective acid with glycerol and phosphorus oxychloride. The product containing both mono-and ring-glycerides was purified from the former by means of sodium bicarbonate. The glycerides obtained are thick liquids.

Chemical Laboratories,
University College of Science,
Calcutta, 26.7.35.
M. Goswami.
A. Shaha.

Note on the biological control of the Pulse beetles by a Trichogrammatid parasite

The minute insects of the *Trichogrammidae* or *Trichogrammatidae* Hymenoptera are known as egg-parasites, as these insects have the habit of depositing their eggs within those of other insects most of which are found injurious to cultivated plants. These parasitic chalcid insects complete their development within the host eggs which are ultimately killed as the result of this parasitization. Such parasitic species which kill their hosts at the egg-stage and themselves are non-injurious to plants, are reckoned as beneficial insects, and offer immense possibilities of biological control of insect pests. The biological control of insects which have become noxious, aims at restoration of disturbed balance of nature by the indroduction of their natural enemies and is less expensive than the use of insecticides. Flanders reports[1] that the species *Trichogramma evanescens* Westw., are bred in American Insectary on a commercial scale for supply inland and oversea for use against destructive insects. The examples of the same species have been reported from India as parasitic on moths, but this or other related parasitic species have been little studied in India as a means of combating insects injurious to agricultural products. We[2] reported in the agricultural section of the Indian Science Congress held in Calcutta, a parasitic species of Trichogrammidae infesting the eggs of the pulse beetle *Bruchus quadrimaculatus* Fabr, which along with *B. chinensis* L., causes great amount of damage to stored pulse. These beetles about 4 mm. in length, deposit their eggs on the seeds of grams, peas and other variety of pulses. These eggs are dome shaped, with the lower surface that is in contact with the outer seed coat of the pulses, flat and measuring approximately 8 mm. in length. The small larvae of the beetles hatching out of the eggs bore through the flat surface of the egg and the seed coat, to reach the centre of the seed which they excavate and destroy. The parasitic species pierces by its ovipositor the convex surface of the beetle's egg before the latter passes into the above larval stage, and introduces its own egg within that of the beetle. The egg of the parasite grows and develops at the expense of the host which is thereby killed. In photomicrograph (Fig. 1) the parasitic egg peg developing within the *Bruchus* egg is shown. The parasite after completing its developmental stages within the egg of the beetle emerges as the winged form by cutting out a small hole on the egg shell of the host. The details of the life history will be published elsewhere.

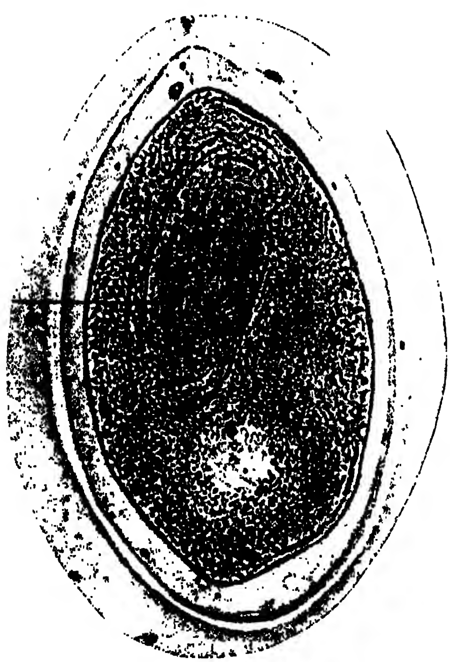


FIG. 1. Photomicrograph to show the parasitic egg within Bruchus egg. ca×124

A rough sketch of the parasitic insect is given here (Fig. 2). The parasitic insect resembles *Trichogramma* specimens except in the number of antennal joints and in the arrangement of hairs fringing the wings. It is named *Chaetostricha mukerjii*, by Mr. Mani[3], of the Indian Museum, who is working on the Indian Chalcids. It is about 45 mm. in length. This parasitic species kept an effective check on the growth and multiplication of the pulse beetles we had been rearing in the laboratory.

It is interesting to note that recently Salt [4] in determining the host selecton of *Trichograma evanescens* Westw., which he obtained from Berlin laboratory, states that this species not only attacks eggs of *Bruchus obtectus* Say, which were thus killed, but shows a slight preference for the *Bruchus* host. But out of 55 ovipositions made by this parasite *T. evanescens*, on the above *Bruchid* host, only *three* specimens completed the life cycle and emerged – which is a poor number as compared to that reared from moths. Salt remarks, therefore, that the Bruchid species (pulse beetles) are not a suitable host for this parasitoid. In view of Salt's above findings and the fact that the *T. evanescens* Westw., has a wider range of hosts as described by Hase, the specificity of attack of the parasitic species under report, on the pulse beetles, deserves special attention. In this case all the *Bruchid* eggs infected by the parasite died, while the latter rapidly multiplied being bred on this host. The first infection of the host took place in the laboratory. We like to mention that we had not been rearing then any other insects. We infer therefore that the *Trichogrammatid* parasite *Chaetostricha mukerjii* Mani, is a natural enemy of the pulse beetles. The life cycle of the

parasite was completed in the month of June within a few days of the first infection but as we had been just at that

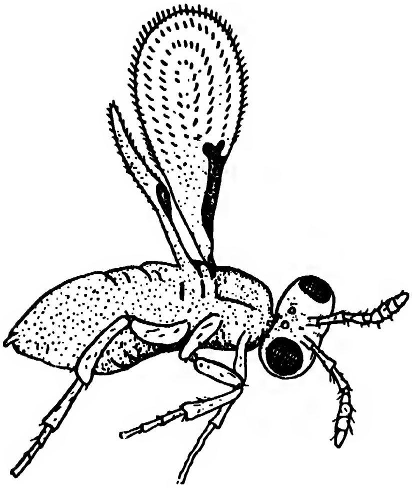


FIG. 2 Sketch of the pa asitic insect Chaetosbic

time in studying the pulse beetles we could not pay sufficient attention to the parasitic species. Attempt is being made in the laboratory to study their life history and host selection.

Zoology Department, Calcutta University. 1st August, 1935.

Durgadas Mukerji. H. Bhuva.

1. *Hilardia 4*, 1930.
2. *Abstract.* (*Agr. Sec., Ind. Sc. Con.*) 1935.
3. *Rec. Ind. Mus. 37*, 1935.
4. *Proc. Roy. Soc. 114*, 1934 ; *117*, 1935.

Also see :

Ashmead : *Mem. Carnegie Mus. 1*, 1904.
Hase : *Arb. Biol. Reichanstl. Land. Forstw. 14*, 1925.
Husain : *Report Proc. Ent. Meetings. Pusa.* 1924.
Thomsom and Parker : Parasitology *19*, 1927.

Manganese in Water

The physiological influence of manganese, even in minute quantities, on animals, and significance of manganese in various phases of plant growth, on chlorosis, on flowering and fruiting, are attracting greater and greater attention recently[1]. Manganese compounds as powerful catalytic agents are well-known and they are most often associated with iron. "Waters for public supply are frequently analysed for their iron content, but relatively seldom for manganese, although this latter ingredient often causes much trouble from consumer's complaints and in service pipes, meters, etc."[2]

A report in a recent issue of the *American Chemical Society* gives the manganese content of seawater as $0{\cdot}2 \times 10^{-4}$ to $1{\cdot}8 \times 10^{-4}$ milligram atoms per kilogram of water [3]. Indeed the presence of manganese is not so uncommon in natural waters and during recent years more attention has been given to the removal of manganese in England as well as Germany and America. Treated waters passing through filter beds over-grown with plants &c may contain mere traces of manganese. It may be of interest, therefore, to report the manganese content of water supplies before and after treatment along with some of the more usual reports.

In the table below I am giving the manganese contents of some of the natural waters in use in the localities they are tapped. A few of the other experimental results are given for comparison.

Bose Research Institute, Calcutta, 22-7-35.

N. C. Nag.

1. *Annual Review of Bio-chemistry 1, 2, 3 ;* 1932, 1933, 1934.

Nag, N C.—The significance of the Presence of Manganese in Plants. *Trans. Bose Res. Inst 8*, 1932-33.

Rhode Island Sta. Bul. 246. Quoted in *Current Science*, *3*, 12, 623.

2. Maxwell, W. H.--*Water Supply Problems and Developments*, p. 82.

3. Thomson & Wilson—Manganese content of Sea Water. *Jour. Amer. Chem Soc.* (1935) 57, 232-236 ; Current Topics. *Jour. Franklin Inst.* May, 1935

In August issue, *omit* A. R. Forsyth on page 143, column 2, lines 30-31. In the supplement, *read* 2,000 *for* 10,000 on page 4, column 2, line 25.

In September issue, *read* Yoni *for* Toni on page 171, column 1, lines 4 and 7.

TABLE

Sample Number Locality	Total Solids at 100°C	Solids after ignition	Total Hardness as ($CaCO_3$)	Permanent Hardness as ($CaCO_3$)	Oxygen Consumption by 30 minutes	Chlorine Cl	Iron Fe	Manganese Mn	REMARK
No. 1 Darjeeling Spring Water	7·1	3·1	1·10	—	0·160	1·21	0·004	0·0071	The two Darjeeling Springs are two miles apart and there is a difference of about 1000 ft. in height.
No. 2 Darjeeling Spring Water.	12·2	4·3	2·00	—	0·213	1·38	0·017	0·0022	The two water were examined in May and June very soft water.
No 3 Tubewell 30 miles from Calcutta (North) depth 360 ft.	37·4	20·4	28·20	7·66	0·055	1·06	0·089	0·0171	—
No. 4 Tubewell North Calcutta depth 260 ft.	92·0	52·0	37·32	17·32	0·053	21·72	0·088	0·0415	—
No. 5 Tubewell North Calcutta depth 225 ft.	105·6	50·6	41·32	20·66	0·062	23·05	0·022	0·0488	—
No. 6 Tubewell South Calcutta depth 260 ft.	49·0	32·4	20·00	8·34	$<$0·01	6·02	0·024	0·0415	—
No. 7 Tubewell further South depth 250 ft.	102·7	88·2	25·67	6·66	0·109	25·21	0·041	0·0434	—
No. 8 Ganges Water at Ebb Tide Babughat 10 a.m. 19-7-35	27·4	10·1	8·33	6·60	0·180	4·97	0·059	0·0025	The water as collected was very turbid. Examination was conducted with filtered water
No. 9 Tubewell 30 miles down Calcutta Depth ?	92·0	44·0	19·32	11·32	0·053	18·50	0·011	0·0110	—
No. 10 Tank Water 30 miles down Calcutta shallow and weedy	111·6	50·0	19·00	10·00	0·249	37·00	0·010	0·0110	Oxygen consumption high
No. 11 Tapwater 18th July 1935	14·8	7·8	8·13	6·66	$<$0·01	1·21	0·008	Trace	The figures for tap water are extremely variable

All the figures are in grams and have been calculated on the basis of 100,000 c.c. of water.

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The Carnegie Educational Trusts

Nobody who has followed the progress of scientific knowledge throughout the past years of the twentieth century can fail to be impressed by the remarkable outburst of activity of the U. S. A. during the post-war period in all branches of intellectual activity. Before the Great War, America was known as the country of Dollars, and her contribution to science, though noteworthy, was not remarkable. In fact, in the sum total of her contributions she was far behind countries with older tradition like England, France, and Germany. But it is well known that during the post-war period, she has not only crept up to the level of these countries, but, in many subjects, is actually forging far ahead of the old world. Some of the greatest contributions to science in recent years have come from America, and in the list of names of those whose contributions to science have been recognized with the award of a Nobel Prize, are to be found many American names, *e. g.* those of Millikan, Michelson, Compton, Morgan, Langmuir Urey and others. In subjects, like astrophysics, which require organization, enterprise and finance America has gone so far ahead of the old world that her contributions have actually outweighed those of the rest of the world put together and she is carrying out such types of work as the old world astronomers can only dream of. Before the War the route of the pilgrim of Science was only one way; now it lies both ways of the Atlantic, and, even in some branches, the route has been reversed from Europe to America. To what circumstances can this remarkable growth of intellectual and scientific life in the U. S. A. be due?

It will not probably be disputed that this is in a large measure due to the remarkable group of charitable foundations for educational purposes endowed by her great millionaires, Andrew Carnegie, J. D. Rockefeller, Guggenheim, Lick, Bartol and others. The American universities have been recipients of large endowments which are not included in the above group. We are not aware what may be the total capital of these charities, but they may amount to several hundred crores of rupees. The capital of the Carnegie Trusts alone amounts to about a hundred crore of rupees. The income from these huge trusts is spent in financing a large number of research institutions, helping research schemes, and providing for the research workers. It is doubtful whether, inspite of the remarkable aptitude of the average American for a life of enterprise, his contribution would have been so great if his schemes were not backed by handsome research grants from all these endowments. In fact, a German professor of astrophysics once remarked to the present writer

"We had in mind all the great work in the way of the physical and trigonometrical survey of the heavens which the Americans are carrying out with such great success, but we have not the money which they command". Another English professor who had early won a great name in astrophysics did not look through his telescope for years because, he said, his instrument was a mere baby compared to the giant American ones, and used to employ his time more profitably in other fields. The present tension in the world has made everybody nervous about the future of civilization. The grim spectre of war haunts the old world. It is not improbable that if another *world* war *breaks* out, the West European civilization may go the way of the forgotten and downtrodden civilization of the East. But the United States of America being free from these old world complications may not only prove to be the torch-bearer for the present civilization, but may actually be the torch-lighter of the civilization to come.

In a separate article we shall review briefly the activities of the Carnegie Institute of Washington, one of the numerous trusts founded by the late Andrew Carnegie, who was born exactly a hundred years ago of poor parents at a small village of Scotland. And in this connection probably it will not be out of place to give a brief sketch of the life and achievement of this remarkable man.

Career of Andrew Carnegie

Carnegie was born of extremely poor parents in 1835 in the small town of Dunfermline. In 1848, when he was only thirteen years of age, his father, who had suffered much for being a member of a chartist organization emigrated to America in order to escape the harsh treatment to which the labourers who had taken part in the chartist organization were subjected by the British Government, and settled in Alleghani, Pennsylvania. Here young Carnegie worked in humble capacity in different factories and gradually worked his way upwards till he became secretary to Mr. T. A. Scott, one of the managing directors of the Pennsylvania Railroad. In this capacity he acquired a unique knowledge of the management of railways and was one of the first to realize the great part which the railways would play in the future. During the civil war of 1860 in the U. S. A. he accompanied his boss, Mr. T. A. Scott, who was assistant secretary of the war to the front for organizing transport for the Federal Army.

He was the first to introduce the sleeping car in 1864 and with the fortune which he made out of this invention he started his great Iron Works, at Pittsburgh, which mainly manufactured steel rails and other railway goods. The railway traffic was expanding enormously in the U. S. A. and being a pioneer, Carnegie was gradually able to amass a huge fortune which was not a little due to favourable protective tariff measures which the Federal Government had imposed. In 1901, Carnegie sold his interest in the various Carnegie Companies to the United States Steel Corporation financed by the great banker, Pierpont Morgan, for a sum of four hundred million dollars and retired from active business. The remaining part of his life he devoted in organizing several charitable foundations.

Carnegie's theory of wealth is summed up in the following sentence :—

"This, then, is held to be the duty of the man of wealth : to set an example of a model, unostentatious living, shunning display or extravagance; to provide moderately for the wants of those dependent upon him ; and, after doing so, to consider all surplus revenues which come to him simply as trust funds which he is called upon to administer,...the man of wealth thus becoming the mere trustee and agent for his poorer brethren."

Trusts in the United States of America

The following is a list of the trusts founded in this spirit :—

Trust	Capital in million dollars
Carnegie Corporation of New York	135
Carnegie Institute of Washington	32
Carnegie Institute of Pittsburgh	28
(This finances a number of cultural and educational departments in Pittsburgh City where Carnegie's Iron Works were located)	
Carnegie foundation for teachers	30
(This is for providing pensions to teachers)	
	225

Besides these trusts there is a Hero Fund (Pittsburgh) with a total capital of ten and a half million dollars for recognition of bravery of those who make heroic efforts to save human life; a trust for International Peace for "speedy abolition of war between the so-called civilized nations."

Mr. Carnegie did not forget the country of his birth; he created various trusts for benefaction of education in Great Britain, particularly in Scotland and his native city of Dunfermline with capital totalling five million pounds sterling.

The Carnegie Institute of Washington is a great combination of research departments located in the different cities of the U. S. A. The institution was reincorporated by an act of the Congress of the U. S. A. approved on April 28, 1904, under the title of the Institution of Carnegie, Washington. It is placed under the control of a board of 24 trustees who meet annually in December at Washington to consider the affairs of the institution in general, the progress of work already undertaken, the initiation of new projects and to make research grants for the ensuing year. The board meets once a year but in the meantime the administration is carried on by an executive committee of several members with the president of the institution as the chief executive officer. The articles of incorporation of the institution declare in general "that the objects of the Corporation shall be to encourage in the broadest and most liberal manner investigation, research and discovery, and the application of knowledge to the improvement of mankind." Three principal agencies to forward these objects have been developed.

The first of these involves the establishment of departments of research within the institution itself to attack larger problems, requiring the collaboration of several investigators, special equipment, and continuous effort.

The second provides means whereby individuals may undertake and carry to completion investigations not less important but requiring less collaboration and less special equipment.

The third agency, namely, a division devoted to editing and printing books, aims to provide adequate publication of the results of research coming from the first two agencies and to a limited extent also for worthy works not likely to be published under other auspices.

During the year under review a sum of about 1·5 million dollars (about 50 lakhs of rupees) was spent on the different research institutions by the Carnegie Institution of Washington. In many of the research projects the funds were supplemented by additional grants from the Carnegie Corporation of New York which is the largest in size and scope of all the Carnegie Foundations According to the Encyclopaedia Britannica (14th edition):

"It exists for the advancement and diffusion of knowledge and understanding among the people of the United States. In 1917, its scope was extended to include Canada and the British Colonies, ten million dollars of its capital being set aside for this purpose. It may spend its large revenue through the other American trusts or through any other suitable channels. ....Forty seven per cent of its income has been devoted to other institutions founded by Andrew Carnegie; its largest outside application was to the National Academy of Science (five million dollars) of the U. S. A".

The Tata Endowments for Scientific Work

A parallel to the career of Andrew Carnegie is found in India in that of the late Mr. J. N. Tata, the great pioneer of industries in the last century and founder of the great Tata Iron Works at Jamshedpur. He was the first to recognize the value of scientific education and scientific research for industrial progress of the country, and set apart 30 lakhs of rupees with which the Indian Institute of Sciences, Bangalore, was founded. His worthy sons the late Sir Dorabji Tata and Sir Ratanji Tata followed in the wake of their illustrious father and supplemented the initial charities by further endowments. Unhappily, the direct line of the Tatas is now extinct, but their properties have been invested in charities amounting to, as rumour says, five to six crores of rupees.

The terms of these charities are generally not known to the public, but from press reports it appears that a

large part of the charities is devoted to educational work. The Tatas have given handsome endowments to the London School of Economics, and the Physical Chemistry Department of the Cambridge University, and it appears that a large number of foreign savants get handsome donations from the Tata Charities; Indians have not been of course totally forgotten. A few Indian scholars in different universities are recipients of Tata Charities.

There is a marked difference in the spirit of the ministration of the two charities. Andrew Carnegie earmarked most of his charities for America, the land of his adoption. Of course the country of his birth which his parents left owing to persecution, and the greater world beyond were not quite forgotten. The benevolence of trustees of the Tata Charities extend over the whole world and India appears to come only for that part of her share which her political importance entitles her to claim. Our great religions have not preached the doctrine of world charity in vain! Well, India is India and America is America!

India's Need for further Research Endowments

We have given this short history of the foundation of the Carnegie Trusts and contrasted it with the Indian Endowments in order to bring home to the minds of the rich men of India the need for liberally financing scientific research which is today largely a matter of organization and finance. Without suitable libraries, laboratories, and research grants, even the most acute brains are unable to achieve anything. Today, the reorganized universities of India are turning out a large number of young men equipped with the latest scientific ideas and fired with the ambition to do scientific work but it is a sad tale how they find no place to work, no future to sustain their efforts and with a sad heart have to turn to humdrum vocations merely to keep the wolf out of doors.

It may seem fantastic to some of our readers that poverty-stricken India should be asked to emulate the country of dollars; but is it not a fact that inspite of general poverty of the masses India contains some of the richest men in the world? In fact, it was recently stated in the daily press that out of 20 richest men in the world not less than five belong to India.

Probably we need not labour much to prove that there is no dearth of rich men in India who can, if they so wish, give handsome endowments in aid of higher research. But it is well known that many of our rich men prefer either to hoard or bequeath their children, and the vision of the few who are charitably disposed rarely goes beyond the range of medieval charities like the founding of temples or dharamsalas, sanctuaries for worn out cattle, or of communal charities. There are a large number of men who can be induced to part with their surplus wealth if they are assured of some honour from the Government.

Some of these foibles of human nature are not the exclusive property of our country, but they are to be found in all countries. In fact, even in a great and advanced country like England, this tendency does not appear to be absent. Sir J. J. Thomson complained in a lecture some years ago that in England there were fewer charitable endowments for education than in America, because there was a tendency amongst wealthy men in England to buy 'honours' with their surplus while in America, there being no honours, the only way to gain distinction was by giving money in charities. In fact some of the Dominion Governments (the Canadian, for example) have found it necessary to abolish 'honours' by legislation.

In India the evil is very rampant but the greater evil is the medieval mentality which our people have still to outgrow. They have still to be convinced that if poverty is to be successfully combated it can be done only by the greater diffusion of scientific knowledge, and by the adoption of scientific methods to agriculture and industry. And this cannot be done solely by the Government. India's rich men must reach to the moral height of Andrew Carnegie who held that "To die rich is to die dishonoured", and we may add that to leave millions for your children or successors which they have not earned themselves is not only to spoil their future but is in most cases actually to push them along the road to perdition!

Irrigation Problems in Bengal

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[In the previous portion of this article published in the September issue of this journal a brief outline was given of the irrigation problems in the different parts of Bengal, which have been created partly by the operation of natural causes and partly as a consequence of human interference with the natural process of building up of the delta in the shape of premature reclamation of the land before it was sufficiently raised. Of the natural causes three fundamental changes were mentioned, *viz.* diversion of the floods of the Ganges and of the Brahmaputra through the Padma and the Jamuna channels and the desertion of the rivers in the Jamuna in Northern Bengal by the Teesta causing serious deterioration in health and in the productivity of the soil in Central and Northern Bengal and in parts of Mymensingh District. The most prominent case of human interference is to be found in the flood embankments (there are over 1500 miles of such embankments maintained by Government alone) in Western and Central Bengal, which, by cutting off the flood spill and depriving the land of natural manure, are mainly responsible for the present unsatisfactory position as regards health and productivity of the soil in these parts. It was emphasized that there is no dearth of natural hydraulic resources. In fact, Bengal has been highly favoured by nature in this respect. Her rainfall, though somewhat erratic in its distribution in Western Bengal, is normally quite adequate to meet the requirements of at least the *Khariff* crop in other parts, and she can count on abundant monsoon floods to nourish her soil with fertilizing silt and to kill the Malaria Larvae if only these floods could be properly distributed. A more equitable distribution of these resources is what is now needed to arrest the rapid march, certainly of Central and Eastern portion of Western Bengal, to death and to restore the old prosperity. It is now proposed to consider how best this could be done.]

Storage Works—the best Solution for the Irrigation Problem in Western Bengal

Owing to the uneven distribution of rainfall artificial irrigation is required in Western Bengal. For this purpose the utilization of local rainfall by means of "bunds" *i. e.* impounding the runoff during heavy showers in small storage tanks close to the irrigable area and utilizing the same at times of scarcity, is possible only to a very limited extent in the western parts of Bankura District where, the country being undulating, some sites for bunds are available. But generally speaking, the valleys are shallow and storage capacities that could be made available would be small. In the Bankura and Birbhum districts there are also a large number of excavated tanks or ponds which are being utilized for irrigation by 'lift'. These tanks were excavated long ago when labour was cheap but they have badly deteriorated by silting. Though, in view of the present rates of labour, restoration of these tanks cannot be considered as profitable commercial undertakings, their value in a year of scarcity can hardly be exaggerated. They are also the only sources now available for irrigating *rabi* crops, as from November till April no rain can normally be expected in these parts. It is therefore suggested that the villagers should utilize their leisure time in improving these tanks. In times of famine when it is necessary to start relief operations the authorities entrusted with the control of these operations should also see that restoration of these tanks and bunds forms an important item in their programme.

But the natural resources on which we have mainly to depend to meet the demands for irrigation and flushing in Western Bengal are the rivers, such as the Subarnarekha and the Cossye in Midnapur District, the Selye, Dwarkeswar in Bankura District, and the Damodar, the Ajoy, the More (Mourakshi), Dwarka, the Pagla, the Brahmani etc. in Burdwan, Birbhum and Murshidabad districts. These rivers have their sources in the Chotanagpur and Santhal Pargana hills, and their catchment areas not being very far from the area to be irrigated, the incidence and distribution of rainfall are more or less similar. Thus though these rivers bring in very heavy floods at times, the time of occurrence of floods does not always synchronize with the time when irrigation is required. Specially in September and October when rain usually fails in Western Bengal and irrigation is required the flow in these rivers also becomes rather scanty. For this reason irrigation by means of daily flow of these torrential streams is possible only to a very limited extent and the cost is proportionately rather high as the necessary diversion and cross drainage works will have to be made to suit the maximum flood discharge which is very heavy.

If it were possible to impound higher up in the river valleys even a portion of these floods which are now running to waste to supplement the daily flow of these rivers in times of scarcity, their irrigable capacities could be enormously increased and the cost also would proportionately be rather low. South-western monsoon seldom fails in Bengal and even in a bad year, sufficient flood discharge is available for storage between June and August to be utilized later in September and October when irrigation is mainly required. This is a special advantage of storage schemes in Bengal as in other parts of India, for instance, in Madras, water has to be stored between October and December for utilization during the next transplantation season, *i. e.* in July and August when rain usually fails. Not only there is considerable loss due to absorption and evaporation during dry months, but stored water has to be supplied at a time when the requirement of crops is the maximum. In Bengal, on the other hand, the stored water will have to be utilized within a short time after impounding; this involves very little loss of water and as the requirement of crops in September and October is the minimum a very high storage duty can be realized.

It has been calculated that while in Madras 1 million cft of stored water can irrigate only 5 acres, it can irrigate over 30 acres in Bengal. Though storage schemes are usually costly this special feature ought to make them rather profitable undertakings in Bengal. Besides, for reasons explained before, irrigation on a large scale is hardly possible from these torrential rivers without storage, and for *rabi* and sugar-cane irrigation storage schemes provide the only solution as no rain can normally be expected when these crops are grown. This is another important feature which requires special mention. Bengal is lagging behind other provinces as regards sugar industry which, owing to high duty recently imposed on foreign sugar, has already developed enormously in other parts of India. Cultivation of sugar-cane on a large scale is not however possible without irrigation from storage as the sugar-cane stands in the field for ten months and requires water throughout the year, and in Western Bengal not only there is no rain during the dry winter months but the rivers also run practically dry. In these days of low prices of paddy not only would the storage schemes considerably improve the economic prosperity of the rayats by enabling them to grow more valuable *rabi* and sugar-cane crops, but by developing sugar industry they will also solve to a certain extent the unemployment problem which is growing rather acute in Bengal.

Possibility of Storage Schemes in Bengal considered

But though storage schemes are likely to be rather profitable undertakings in Western Bengal so far we have been able to discover only two good sites for storage dams, *viz.* one across the Dwarkeswar river at Suknivasa in Bankura District about 15 miles above Bankura and the other across the More (Mourakshi) river at Mossanjore in the Santhal Parganas about 21 miles above Suri. Preliminary investigations for both these schemes are being made and it is expected that about 200,000 acres of paddy fields in Bankura and Burdwan districts could be irrigated by the former and 4,32,000 acres in Birbhum and Murshidabad districts by the latter,

besides irrigation of *rabi* crop and sugar-cane almost to the extent up to which cultivation of these crops would be possible within the area commanded. The site for the proposed dam at Mossanjore is almost an ideal one, being a narrow gorge (about 2,000 ft. wide) bounded by hills on either side through which the More is descending from the Dumka plateau into the plains of Western Bengal. Though the site lies within Bihar & Orissa it is of no use to that province. On the other hand it may prove to be a very valuable asset for Bengal if the Government of Bihar & Orissa would only permit its utilization.

Further investigation may no doubt reveal the existence of suitable sites for storage dams across the upper valleys of some other rivers, specially the Subarnarekha, the Damodar, Ajoy and the Bansloi, and in view of the overwhelming advantage of storage schemes, future investigations should proceed on this line. As regards flow irrigation schemes *i. e.* irrigation by daily flow without storage, the Cossye in Midnapur District, the Damodar in Burdwan District and the Bakreswar in Birbhum District have been fully tapped to irrigate about 80,000, 1,80,000 and 10,000 acres respectively and though annually they bring down millions of cft. of water during floods which now run to waste often causing havoc to the country side by the breaching of the protective bunds it does not seem possible to extend irrigation by these rivers any further without the help of storage.

Several other flow irrigation schemes in Western Bengal have been investigated but owing to the present financial stringency their construction has not yet been put in hand. Apathy of the rayats to apply for irrigation leases and the present method of accounting which takes into consideration only the direct revenue realized from irrigation projects, ignoring the increase of indirect revenue which these projects bring in by improving the economic condition of the people and increasing their purchasing power, are also standing in the way of development of irrigation in Bengal. It may be mentioned that the present Irrigation Act stands on a voluntary basis; that is to say, it is entirely optional to the rayats to apply for canal water. Rayats are, however, mostly illiterate and cannot appreciate the benefit of canal irrigation in the shape of timely distribution of water and the manurial value of silt carried by canal water. They no doubt realize the value of canal irrigation in an abnormal year of very low rainfall but as this occurs only once in 5 to 7 years or so they feel shy of entering into a binding contract for a long period and prefer to gamble with the rainfall till the last moment.

No irrigation project can under the circumstances be made a financially sound concern unless the voluntary basis of the present Act is changed and the rayats are compelled by law to take canal water every year within the commandable area of the irrigation canals. Such a compulsion is justified as use of canal water will give an extra yield owing to the manurial value of silt and equitable distribution of water suited to the requirement of crops. Besides, irrigation in this area provides the only solution for full utilization of the land and cultivation of money crops like sugar-cane, oil seeds, cotton etc. And as more than 80% of the people are dependent on the land the irrigation schemes are perhaps the most important development measures that should be undertaken for the economic uplift of the country. If the present method of charging a fixed water-rate is substituted by a suitable system of sharing with the rayats only the extra yield caused by irrigation, there should not be any complaint on the ground of price fluctuation during the pendency of the lease which appears to me to be quite a legitimate objection under the present system. The risk involved under this arrangement, *i.e.* whether the project would be financially sound or not, is all on the side of the Government while the rayats will surely stand to gain by taking in a share of the increased yield which they have not earned but which has been caused solely by the irrigation at Government cost.

Flood flushing—the most Pressing Need for the Eastern portion of Western Bengal

For the purpose of flushing the eastern portion of Western Bengal the sources of supply are the same rivers which in their upper reaches have to be tapped for irrigation. The area is flat and has been built up by the silt carried by these rivers particularly the Cossyo in Midnapur District, the Damodar and the Ajoy in Burdwan District. But

before the land could be sufficiently raised by such natural deposits it began to be reclaimed by flood embankments long before the British occupation. In those days, these embankments do not appear to have been efficiently maintained by the zamindars and breaches were frequent. Though this caused temporary inconvenience and damage to the people, the land used to be flushed occasionally by silt laden floods and the health and productivity of the soil did not deteriorate to the extent as it has done now. Evil effects of these embankments were not of course realized in those days and for more efficient maintenance they were gradually taken over by Government and improved with the object of preventing breaches as far as possible. In consequence, though the breaches are now less frequent and the protection enjoyed by the people is now more thorough, this very fact has brought into prominence the evil effects of these embankments. The breaches are now rare and even when they occur they are closed immediately. In consequence, the land has been deprived of even the occasional flushing with silt-laden flood water which it was enjoying when these embankments were being inefficiently maintained by the zamindars. This is not only causing progressive deterioration in the health and productivity of the soil but the difficulty of draining these areas is becoming more and more acute. For the embankments have not only prevented the gradual rise of the land by silt deposits during flood flushing but on the other hand it is actually becoming gradually lower, though at a very slow rate, due to the loss of the surface soil washed away by the rains. To make the case worse the floods, confined within embankments and unable to spill and deposit on the land as was intended by nature, are depositing a portion of the silt-contents within the river beds which are gradually rising. The irrigation engineers in Bengal are thus faced with the most unenviable situation created by the lowering of land to be drained and rise of river beds into which the drainage has ultimately to be disposed of, and in some area it has already become impossible to drain by gravity as in Sabong Moyna Circuit in Midnapore District. And a very serious situation is developing by the attempt to confine the floods within the narrow river channels by means of earthen embankments. As a direct consequence of embanking these rivers preventing free spill over the country side, there was a considerable rise in the flood level soon after these embankments were constructed and this level is tending to rise higher and higher owing to the gradual rise of the river beds, necessitating higher and higher embankments to prevent their overtopping by the floods. Indeed, during the last Damodar floods it was observed that, though the embankment was over 20 ft. higher than the country level, at some places it was about to be overtopped, which could be prevented only by raising the embankment during the progress of the flood. It is needless to say that breaches at such places would have been attended with serious consequences to the country side owing to the terrific velocity which a wall of water over 20 ft. high ejecting out of the breach would have generated, sweeping away everything that would come in its way—houses, cattle and even human beings. This potential danger to life and property that is likely to be caused by concentrated discharge through breaches at low places needs special mention and it is here, where high embankments have necessarily to be maintained, that breaches are more likely to occur. In fact, there is a limit as regards depth of water which can safely be withheld by unprotected earthen bunds and at some places in the Damodar embankment this limit has almost been reached and, if the flood level rises higher, it will probably be necessary to go in for expensive surface protection of these embankments. But even then these earthen bunds can hardly be made breach-proof, for a tiny little rat-hole may easily lead to a disaster and where there are hundreds of miles of such embankments to look after, it is almost impossible to ensure that all these tiny holes have been detected and attended to in proper time. In fact, such holes are usually covered by vegetation and can only be detected when the flood level has reached their river side ends, and if these ends are located high up the slope they may not be detected till the flood has risen very high, when it may be too late to do anything. In view of these difficulties occasional breaches in the unprotected earthen embankments and the consequent loss of life and property caused by concentrated discharge can hardly be avoided and it is surprising that they do not occur oftener than is the case at present.

On the other hand what would have happened if these rivers were left in their natural condition? Condition now prevailing in Eastern Bengal would furnish the answer. No doubt there would have been flooding of the area now inefficiently protected by the embankment, but the flood being allowed to spill over the country side the depth of flooding would have been much less and it would be lower and lower as the land rose higher and higher by the silt deposit. And what I wish to emphasize there would have been no loss of life or property which is now caused by the high velocity of concentrated discharge through breaches nor there need have been any distress among the people, for, being accustomed to annual flooding, they would have erected their houses on mounds above the flood level as is the practice in Eastern Bengal.

The position is undoubtedly very serious and unless a bold policy of improvement is followed this tract will, in course of time, revert to swamps and jungles from which it was prematurely reclaimed in the olden days. The ideal solution would be to remove the cause of the deterioration *i. e.*, the embankments and raise the land and increase its productivity by allowing the flood water to spill and deposit the silt which is very rich in manure. Where possible, this solution should certainly be adopted. Millions of tons of this valuable silt are now being carried away by the floods and lost to the country and the land for which this silt was intended by nature is starving. Above the tidal limits where the water is sweet such natural flood flushing need not necessarily destroy crops nor cause such acute distress amongst the people as is now being caused occasionally by the concentrated discharge through breaches in embankment, for, when the embankments are removed the flood level will also fall considerably lower as compared with its present level and as the floods in these parts are short-lived, lasting not more than 2 or 3 days at a time, such flooding may even be beneficial to the crops except in years of very high floods when, no doubt, the crops will be destroyed till these lands have been sufficiently raised by the silt deposit. The loss however will be more than compensated by the increased yield in normal years due to the manurial value of silt and the improvement in health. And as regards distress caused to the people by the collapse of houses it can certainly be avoided or at least minimized by erecting houses on earthen mounds and by avoiding mud walls as is the practice in Eastern Bengal.

In most of the areas, however, owing to important vested interests such as existence of Railways, towns etc. such uncontrolled flood flushing is hardly practicable and here we must be satisfied with limited flushing as may be found possible by drawing the flood water through regulated escapes to be built on these embankments. It is quite possible to introduce such limited flushing in the area lying between the Cossye, the Selye and the Rupnarain rivers in Midnapur district and that lying between the Damodar, the Banka and the Hooghly rivers in Burdwan, Hooghly and Howrah districts. For the latter area, contour survey was recently made and a special officer has been deputed to do the necessary investigation and prepare the estimate. In the first place, the network of channels which formerly used to serve both as spill and drainage channels but have now badly deteriorated by being cut off from the parent rivers by means of embankments, have to be improved. For the area is already waterlogged and we can not possibly introduce any flood water unless adequate drainage outlets have been provided. After the improvements of these drainage outlets, regulated escapes will have to be constructed at suitable points in the embankments to draw the floods from the Damodar and carry the same through these channels. It will also be necessary to construct a net-work of minor channels for equitable distribution of this water over the land.

Restoration of the Ganges Spill—the Pressing Need for Central Bengal

In Central Bengal where the problems and their solution are more or less similar, the source of supply for the purpose of flushing is of course the Ganges. The Central Bengal has been built up by the silt carried by the Ganges which in the olden days used to distribute her waters mainly through the Bhairab, which probably constituted the easternmost branch, and the Bhagirathi which in the lower reaches, trifurcated into three

main branches at Tribeni a few miles above Hooghly *viz.*—the Jamuna, the Bhagirathi (or Hooghly) and the Saraswati. But since the diversion of the Ganges flood through the Padma channel in the 15th or 16th century, these rivers began to deteriorate. The Bhagirathi, which once constituted the main channel of the Ganges, now remains practically cut off from this river except during floods and even then the share of the Ganges flood it now receives is almost insignificant as compared with what used to pass before the diversion. In consequence, its western and eastern branches *viz.* the Saraswati and the Jamuna are now dead and the Bhagirathi also would probably have shared the same fate but for the rivers in Western Bengal which have their outfalls into this river and tidal flushing in the lower reaches, which, thanks to the frequent dredging of bad shoals by the Calcutta Port Trust and other conservancy measures, is being allowed as freely as is possible. But in the upper reaches, the river is fast deteriorating and even in the lower reaches its condition is not free from anxiety as further deterioration will threaten the very existence of Calcutta as a Port. The Bhairab also is now dead having been cut through first by the Jalangi and then by the Mathabhanga. These two spill channels of the Ganges opened comparatively recently as if nature, being repentant of the mischief caused to Central Bengal by the diversion of the Ganges flood to the East, tried to make good the losses with the aid of these channels. And undoubtedly they did a lot of good for a time. But they are also fast deteriorating and though not completely dead yet, can no longer draw sufficient water from the Ganges to be able to spill over the land nor to keep their distributaries alive. The large number of distributary channels such as the Nabaganga, the Chitra, Kobadak, Betna, Kodla etc. which used to distribute this spill equitably over the entire area have also died or are dying, resulting not only in the progressive impoverishment of the soil but acute difficulty in drainage and water-logging. Practically the whole area traversed by these channels is highly malarious and unless the old condition of flushing by the Ganges flood can be restored, this area will also share the same fate as predicted in case of embanked areas of Western Bengal *viz.* revert to swamps and jungles. The principal spill channels which are not yet completely dead and on which we have to depend for the purpose of drawing from the Ganges and carrying a portion of her flood for flushing this area are the Bhagirathi, the Jalangi and the Mathabhanga. In view of the apparent tendency of nature to enrich the Padma at the expense of these rivers, the question of primary importance to be considered in connection with their improvement and that of their offtakes is not so much the danger of uncontrolled openings as is apprehended in connection with the removal of embankments in Western Bengal, but whether an appreciable portion of the Ganges flood can at all be induced to pass through them in preference to the Padma of which the hydraulic conditions are of course much more efficient. The late Sir William Willcox advocated the constructions of a barrage across the Ganges with a view to induce a portion of the Ganges flood to pass through these channels. Though it is no doubt a very sound proposition technically, the cost of the barrage together with that of river protective works that would be necessary to prevent outflanking and their maintenance would be so heavy that those who have to finance the scheme may not be disposed to seriously discuss it in the present economic condition of Bengal. We have therefore to consider the question of improvement of these rivers even without the barrage.

The first consideration is whether nature has permanently forsaken this tract or its desertion by the Ganges flood is only a temporary phase.

It may be mentioned in this connection that in the process of building up the delta the river has a tendency to oscillate within wide limits; first flowing in one side and after the riparian tracts have been raised to a certain extent it bursts through its banks and opens up a new channel through the comparatively lower areas of the contiguous tract and so on. After these latter tracts have been raised sufficiently the process is reversed to raise still higher the tract which has been raised before. This is perfectly consistent with the natural conditions governing the flow of a river which, following the immutable laws of nature, always tends to take the line of least resistance. The lower land not only gives it better hydraulic slope but by providing

better facilities for spill and consequently abstracting larger portion of its silt burden, helps to maintain the river in a more efficient condition than if it has to pass through higher land. It is therefore reasonable to expect that after the Ganges has raised the tract through which she is now flowing she will again turn her attention to Central Bengal and the present decadent rivers of these parts may improve.

Reference may also be made in this connection to the report by the Committee presided over by the Hon'ble Mr. C. J. Stevenson Moore on the "Hooghly rivers and its Head waters". The Committee stressed the importance of the Ganges freshets carried by the Nadia rivers (the Bhagirathi, the Jalangi and the Mathabhanga) for the preservation of the Hooghly and came to the conclusion that these rivers pass through successive phases of deterioration and improvement and that there is no definite proof that have permanently deteriorated to any great extent. We may have to wait for decades or perhaps centuries before nature turns her attention to Central Bengal and ends the present phase of deterioration of these rivers. But having regard to this finding of the Committee, it does not appear to be unreasonable to expect that it may perhaps be possible to accelerate the end of the present "temporary" phase of deterioration and advent of that of improvement by artificial action. And the problem not only affects the decadent tracts of Central Bengal the very existence of which as a place for human habitation depends on its satisfactory solution, but also the interests of the Port of Calcutta and the maintenance of the Hardinge Bridge, which would be rendered comparatively easier if an appreciable portion of the Ganges flood could be diverted above the bridge and made to pass through Central Bengal.

Recently I had occasion to inspect the offtakes of these rivers and was impressed by the vast changes that are taking place in the regime of the Ganges. The menace to the Hardinge Bridge due to its possible outflanking, to prevent which more than a crore of rupees is being spent by the railway authorities on the necessary protective works, is really the effect of the changes that are taking place higher up the river. Near the bridge the tendency of the river appears to be to revert back to the course which existed in 1868 *i. e.* to flow along its southern flank. The next bend higher up where the main current strikes the opposite or north bank is at Sara and the reflex bend higher still in the south bank contains the present offtake of the Mathabhanga near the Jalangi village. It is reported that some years ago the entrance of the Mathabhanga was masked by an extensive *char*; but a very wide and deep channel is now hugging the south bank and violent erosion is going on for miles on either side of the offtake, which is also showing a definite tendency to face the parent river downstream—an indication that the Mathabhanga will probably improve if other conditions are favourable. In fact, here also the Ganges appears to be trying to take the course followed in 1868 when the Mathabhanga was quite a vigorous river. Similarly the positions of the present Jalangi offtake at Akrigunj and the Bhagirathi offtake at Nadia appeared to be favourable though not to the extent as observed in the case of the Mathabhanga. I gathered this impression from eye observation only and it is not of course possible to express a definite opinion without a survey showing these changes as the river is much too wide to be able to visualize them with eye observations alone.

But mere improvement of the offtakes is not enough; it merely shows the tendency of nature. To be able to utilize fully these tendencies to our advantage, it is necessary to improve the carrying capacities of these channels and provide suitable outlets or distributary channels of adequate capacity, and other facilities for spill over the country side. For, unless the increased discharge that could be drawn in view of the favourable position of the offtakes could be carried by these channels and disposed of, no material improvement over the present condition can be expected. As regards the Mathabhanga, suitable outlets are available such as the Kumar, Nabaganga, the Chitra, the Kobadak, the Kodla, the Betna, the Ichhamati etc., which, though in a very bad condition, could be improved at a comparatively small cost. As for the Jalangi and the Bhagirathi such outlets will have to be provided.

But, though the improvements of these channels and their annual flushing will certainly mean consi-

derable improvement over the existing condition from the sanitary point of view, neither can such improvements be maintained nor can we expect to arrest the growing deterioration in the productivity of the soil and to restore the old prosperity without land flushing on an extensive scale. The function allotted by nature to these spill channels in deltaic Bengal is that they should spill over the land during floods and deposit the highly fertilizing silt carried by the flood water. Being relieved of the silt burden, the comparatively clear water should then flow down these channels and maintain them in efficient condition. If not allowed to spill, a good portion of the silt content of flood water entering these channels, which the reduced velocity due to flatter gradient available in the lower portions of Bengal is unable to transport, will naturally deposit in their beds, and the channels will again deteriorate. Improvement by dredging or by hand cut, where feasible, will no doubt be necessary initially to give these works of improvement a good start but it is impossible to maintain a river by dredging along, for, apart from the question of cost, the dredged spoil has necessarily to be deposited on the banks close to the river channel which will go on rising as the dredging continues and soon reach a height beyond the lift of the dredger. An essential condition of success therefore is that, after their initial improvement, forces, which were in operation before, when these channels were in live condition, should be restored so that they may again be self-maintaining, or, in other words, they should be allowed to spill extensively over their banks without hindrance as as far as possible. To what extent this may be done it is not possible to say without a contour survey with lines of levels taken at fairly close intervals and the detailed investigation made as regards the vested interests that are likely to be affected, such as railways, towns and condition of cultivation prevailing in different parts, such as the time of sowing and harvest, and if the crops are likely to be damaged by flooding, whether the soil is not suitable for growing crops of different variety which could be harvested before, say, August when the channels would normally begin to spill, or East Bengal paddy which grows with the rise of water level. The problem is undoubtedly a very complicated one and what I wish to emphasize is that no piecemeal solution is really possible but it has to be thought out and dealt with comprehensively.

It is not however my intention to discourage the very laudable efforts that are being made by the district boards of Nadia and Jessore to resuscitate some of the dead rivers in those districts. The opening of the "Guznavi cut" two years ago and of the "Bijoy cut" the other day which are intended to restore the old outlets from the Mathabhanga into the Nabaganga and the Kobadak (Kapatakshi) respectively is a very encouraging sign that the people have now fully realized the seriousness of the problem and helping within their limited means towards the solution. But what I wish to emphasize is that too much should not be expected from these cuts. They will no doubt function for some years and by flushing the moribund channels with silt laden water will certainly improve the sanitary condition of the area through which the channels pass and will thus more than justify the small cost involved. But, unless they are allowed to spill, the improvement that has now been effected is not likely to last long. Besides, some more cuts of this nature located so far away from the offtake of the Mathabhanga are likely to affect the Mathabhanga itself in the lower reaches unless steps are taken simultaneously to draw through the offtake more and more of the Ganges flood. In fact, our object should be not to feed these cuts at the expense of the lower reaches of the Mathabhanga as that would merely transfer the complaints from one area to another but to draw more and more of the Ganges flood through her upper reaches. From this point of view it would be an advantage to commence improvement of the outlet of the Mathabhanga by means of similar cuts from her head reaches downwards, for the nearer is the outlet located to the offtake of the parent river the more will it help in drawing from the Ganges and in keeping the offtake and the upper reaches clear of shoals.

In their lower reaches these channels are tidal and, except where free tidal flushing of their spill areas has been interfered with by premature reclamation, their condition is not so bad and they are still serving the purpose of drainage and communication —a very valuable natural asset, which should be preserved at all cost. Mere tidal flow, unless reinforced by supply of upland water, can-

not however maintain any channel for an indefinite period. Tides in these parts carry a large proportion of silt with which nature is trying to raise the delta now deserted by the Ganges floods. But it is only a question of time when the spill areas having been raised upto tide level, this silt, unable to spread over the land, will deposit in the channel bed in larger and larger quantity and will finally choke it. A gutter channel will probably remain for draining the local rainfall but the channels will no longer be fit for navigation. Besides, with the reduction of pressure of sweet water from above the salt water limit is also being pushed up those channels and a serious situation is likely to arise if the upper reaches of these channels continue to deteriorate and supply of sweet water is further reduced.

Improvement of these channels and diversion through them a portion of the Ganges flood thus appear to be necessary even in the interest of the tidal portion of Central Bengal though its present condition is not quite so bad as the upper areas. With the help of a copious supply of sweet water, it will be possible not only to maintain those tidal channels permanently but also to push down the salt water limit and extend cultivation more and more towards the sea-face even without embankments as is the practice in Eastern Bengal.

Conservation of Waterways—the Pressing Need for Eastern Bengal

Together with the tidal portion of Central Bengal Eastern Bengal possesses very important natural resources in her navigable channels, value of which in promoting trade and providing facilities for cheap communication can hardly be exaggerated. We have first the principal highways *viz.* the Ganges, the Brahmaputra and the Meghna providing water communications with the neighbouring provinces of Behar & Assam. Then we have the network of feeder channels connecting these main waterways with the trade centres including Calcutta, one of the important ports in the world. Again, in Eastern Bengal which is inundated by the floods of these rivers, it is possible during the monsoon to carry goods by water practically from every village to the nearest feeder channel and from there to one of the principal highways for transport to the several trade centres. This is perhaps unique in the history of the world for though there are other countries possessing natural waterways I do not know of any, where the system of internal boat communication has been so thoroughly planned by nature as in these parts. Apart from its value to trade it is also providing employments to hundreds of thousands of people, importance of which in a province like Bengal where the pressure of population is already being felt, can hardly be exaggerated.

The importance of conserving and improving, where possible, this valued gift of nature is therefore obvious. As regards the principal highway no attention is really needed except during the dry months when it may be necessary near bad shoals to train the available flow through particular channels so as to increase the depth of water to suit the requirement of navigation. Large quantity of the discharge of the Ganges and her tributaries is however being utilized for irrigation in the upper provinces and so long as it is extracted during the monsoon months it does not seriously matter as there is plenty to spare. But further extraction of low water discharge of these rivers should be a matter of serious concern to Bengal and Behar as not only this is likely to endanger navigation in the Ganges during low water season but after the improvement of her spill channels in Central Bengal, we shall require more and more of this discharge to pass through them to keep them efficient.

It therefore seems necessary to keep an eye on the future development of irrigation schemes in the Ganges basin in the upper provinces and as the interests of these provinces are likely to conflict with those of Bengal, the necessity for the establishment of a representative body to adjudicate those interests has to be considered. But the main problem which we have to face at present in the matter of improving facilities for communication by water is with regard to the feeder channels connecting these Principal highways, specially with Calcutta. In the olden days, when the Bhagirathi was in better condition, Calcutta was of course, directly connected by water with the Ganges. Later as navigation through the Bhagirathi became more and more difficult the Jalangi and the Mathabhanga

were being utilized for the purpose. These rivers no longer give access to the Ganges except during the rains and it is doubtful if they can be improved sufficiently within reasonable cost to restore the old facilities for navigation. We have therefore to depend solely on the tidal channels in the Sundarbans to get access to the Ganges from Calcutta. But in the absence of upland water supply and due to premature reclamation of spill areas, these channels are fast deteriorating and the steamer route through the Sundarbans is being gradually shifted more and more towards the sea-face. It has been stated before that along with the improvement of the rivers in Central Bengal in their upper reaches and diversion through them of a portion of the Ganges flood, their tidal reaches will also automatically improve and with the copious supply of upland water thus available a solution will be found to maintain these tidal channels on a permanent basis which is so vitally necessary in the interest of inland navigation in Bengal.

In this connection it may be mentioned that to shorten the distance by water between Calcutta and the Ganges, the Madaripur Bil Route was opened early in the present century. As the name indicates it was a passage about 20 miles long cut through a series of bils connecting the Madhumati at Manickdah with the Kumar river at Fatehpur and through that river and the Ariel Khan with the Ganges. The scheme was highly successful as the spill of the Ganges and the Madhumati after depositing the silt on the bils and the country-side lying to the north and west of these channels was sufficient to give them a thorough flushing, as they were more or less self-maintaining. This route practically monopolized the whole volume of waterborne traffic between Calcutta and Behar and Upper Assam and apart from immense benefit to trade, it was also yielding decent revenue to Goverment. But to meet the demand of the growing heavy traffic it was considered necessary to widen the bil route which, in consequence, began to draw more and more of the available spill supply at the expense of the Kumar which for want of sufficient nourishment is now being starved to death and navigation is no longer possible during the dry months. It is a highly complicated subject and cannot be properly dealt with in a short article. But I mention it just to indicate that in this case also we have got the requisite natural resources in the large volume of flood water now running to waste in the Ganges and the Madhumati and the problem is one of diverting a portion to feed the Kumar which is starving to death for want of adequate supply.

While dealing with this subject of communication I may be permitted, to sound a note of warning specially to those, who live in areas which are still being favoured by nature in the shape of annual flood flushing. We hear talk of extension of railways in those parts, for instance, rail road to Barisal, to Madaripur and between Dacca and Aricha etc. Improvement of facilities for communications are certainly necessary as these are vital factors in the cultural and economic uplift of a nation. But rail roads in these parts have to be carried on high embankments materially interfering with the flushing arrangement devised by nature. We should not therefore repeat the mistakes as made in the case of Western Bengal and instead of embanked roads or railways, our policy in future should rather be to meet the demand for communication in these parts by improving the existing waterways and making new waterways where none exists at present.

Resuscitation of Moribund Rivers—The Pressing Need for Northern Bengal

As regards Northern Bengal, I must confess that our informations are rather scanty as it is only in recent years that this area has been brought within the purview of the Irrigation Department. I have already stated the problems but in the absence of adequate data it is hardly possible to indicate a definite solution. The western portion of this area is traversed by the Mahananda which is a river of fair size and can be utilized to meet the demand for irrigation and also for flood flushing to a certain extent. The other rivers such as the Atrai, the Jamuna, the Karotoya and the Punarbhaba, after their desertion by the Teesta which used to feed them originally with silt laden water from the Himalayas, have now badly deteriorated and cannot serve even as efficient drainage channel.

The area has been built up mainly from the north by these rivers but is also being raised partly by the Jamuna from the east and the Ganges from the south so far as it is commanded by the flood level of these rivers. In consequence, there is an extensive depression in the middle in the heart of which lies the Chalan Bil. It is becoming extremely difficult to drain the area, and in years of heavy rainfall it suffers considerable damage. It appears to be possible to improve the drainage of this area by clearing the outlet channels leading to the Jamuna and improve the Karotoya and other rivers to serve as efficient drainage channels. Though this would certainly be an improvement over the existing condition it will not help in raising this area for which purpose flushing by silt laden water is essential.

It might have been possible to utilize the Boral for this purpose and raise a portion of this depression by the silt drawn from the Ganges. But the railway authorities feel rather nervous about the development of this river, which might, in their opinion, endanger the safety of the Hardinge Bridge. We have therefore to depend mainly upon the Teesta for the supply of silt laden water and to restore the old condition *i. e.* resuscitate the Atrai, the Punarbhaba, the Karotoya, as far as possible. There are sufficient resources for the purpose as the Teesta brings down enormous floods which are now running to waste into the Brahmaputra. As these rivers were once fed by the Teesta, levels also will probably be suitable. But it is not possible without investigations to express any opinion as to whether such diversion which will certainly necessitate the construction of a barrage across the Teesta at an enormous cost would be a financially sound proposition.

I have not made any attempt to give an idea of the cost of the various proposals discussed in this article nor is it possible to do so without detailed investigations. Nature has been rather kind to Bengal and has given her water resources in abundance which are now being mostly wasted. Soil is also mostly soft alluvium and presents no engineering difficulty in its excavation either for the purpose of improving moribund channels or for making new ones. It is now left to us to utilize these resources if the growing deterioration in health and productivity of the soil has to be arrested and the old prosperity of rural Bengal restored.

The Quetta Earthquake and its Lessons*

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There seems to be no doubt that India is passing through a period of increased earthquake activity. During the past nine years this country has been visited by ten severe earthquakes, whereas during the preceeding twenty-six years the number was only five. A similar increase in activity is found in Baluchistan. During the last 83 years an earthquake sufficiently severe to cause damage to buildings has occurred on an average once every five and a half years. But there was a period of quiescence between 1909 and 1931 during which no severe earthquakes occurred, which has been followed by a period of activity in which there have been three severe earthquakes in three and a half years. These are disquieting facts, for one is naturally concerned to know how long this period is going to last, and when and where the next earthquake is going to be.

Sir Thomas Holland is reported to have said last year that seismology is not a science, since it cannot foretell the future. The latter part of the statement is unfortunately true, though whether on that account seismology is to be denied the dignity of being called a science is a matter for argument. The increased study of earthquakes in India, which is now being taken up in earnest, may lead to valuable results. But it has to be confessed that seismology is still in childhood.

Previous Earthquakes in Baluchistan

If we consider the history of previous earthquakes in Baluchistan, two facts of interest emerge. One is that earthquakes, so far as our records show, have never occurred successively in the same place. The other is that the most severe earthquakes have been confined to an area within a radius of about 150 miles of Mastung. Earthquakes have also occurred in other parts of Baluchistan and Sind, but they have not been very severe. These facts are of considerable importance. The first seems to indicate that the epicentre of the present earthquake, along the line Quetta-Mastung-Mandi Haji, is unlikely to be the epicentre of the next earthquake in Baluchistan. The second suggests that such places as Karachi, Hyderabad (Sind), and Sukkur are unlikely to be visited by a very severe shock. This latter conclusion, however, is perhaps a dangerous one, as the following instance will show. In 1904, Montessus de Ballore published a short account of earthquake activity in India. He divided India into several regions and considered each separately. One of these regions he called 'Upper India', an area which included the whole of the United Provinces and a large part of Bihar. As this area had been comparatively free from earthquakes during the past century or two, Ballore concluded that the area was 'rather stable'. Since then the disastrous earthquake of 1934 has occurred within this area, showing how dangerous it is to prophesy regarding earthquakes. All that one can safely say is that there is a definite earthquake belt in India, extending from Cutch, through the Baluchistan hills and the Himalaya, to the Burmese mountains, and including the adjacent plains, in any part of which a severe earthquake may occur. The rest of India south of this belt can be regarded as fairly safe from severe earthquakes. It is unfortunate that the earthquake belt coincides with the most populated tract in India.

The Quetta Earthquake

As regards the recent earthquake in Baluchistan, the main facts have already been made known in the lay press and elsewhere, and they need not be repeated here. On the accompanying map of Baluchistan and Sind two lines are drawn in red. The inner one shows the position of the epicentre of the present

* Published with the permission of the Director, Geological Survey of India.

earthquake, where the most severe damage occurred. The outer broken line indicates the limits of the area outside which the earthquake was not generally perceived. This is a comparatively small area, little more than 100,000 square miles, which is rather remarkable in view of the intensity of the shock at the epicentre. The smallness of the area is no doubt largely to be attributed to the fact that the earthquake occurred during the night when most people were asleep. Had it occurred during the day, the area over which the shock was slightly felt might well have been several times as large.

The shape of the outer line is of interest, especially the way it extends up the Indus valley. It is a well known fact that towns situated on alluvium generally suffer more damage during an earthquake than those situated on solid rock. It seems that the earthquake waves, as they leave the solid rock and pass up into the overlying covering of alluvium, become intensified, in the same way that peas on a drum jump about when the skin of the drum is made to vibrate. A similar phenomenon was observed in the case of the 1931 earthquake.

Earthquake-Proof Construction

One of the most striking lessons of the earthquake was the contrast between the way in which high, unwieldy, or poorly constructed buildings uniformly

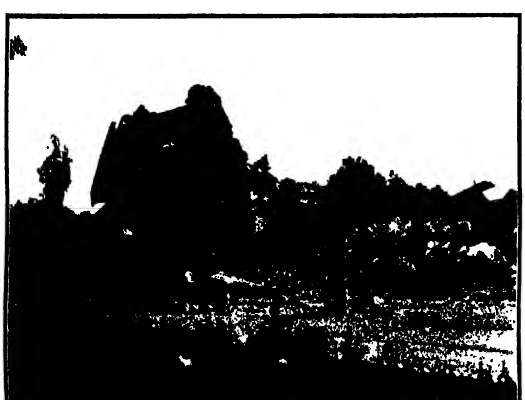

Fig. 1. The Railway Institute, Quetta.

collapsed, while bungalows which had recently been constructed by the North Western Railway on earthquake-proof lines escaped without a crack. There has been much discussion lately as to the best method of designing buildings to withstand these severe shocks and some of the designs which have been advocated have been very complicated. In Quetta, however, we had an actual demonstration of the efficacy of one inexpensive type of construction which stood the test of a severe earthquake. The accompanying photographs tell their

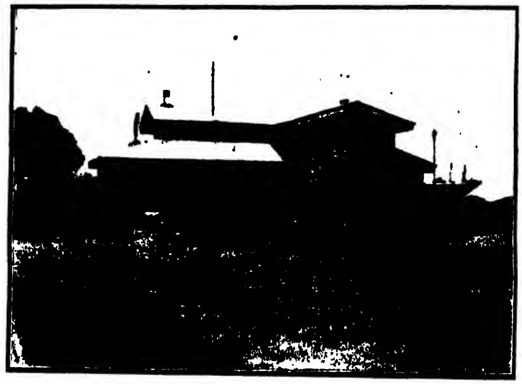

Fig. 2. N. W. Ry. Earthquake-proof bungalow, Quetta.

own story. In one is shown the Railway Institute, a high single storey building, constructed of bricks with a rather poor mortar, which was completely ruined by the earthquake. In another is shown, in striking contrast, one of the new railway bungalows situated close to the Institute. In this bungalow, the main essential of earthquake proof construction, namely rigidity, has been attained by the use of vertical and horizontal iron rails, which have braced the building together in all directions. A third photograph shows a small, square, compact building situated in the midst of the ruined city. It is frequently stated that it is impossible to construct earthquake-proof houses sufficiently inexpensive to suit the poorer people. But the type of building illustrated cannot be very costly, and seems to point the way to the solution of the problem. The difficulty is that the ordinary village or town dweller is not instructed in the way that houses should be built when situated in an area susceptible to earthquakes, with the result that after every earthquake he builds again the same type of building to which he is accustomed, and in the next earthquake it is again damaged, maybe with loss of life. The fourth photograph shows a high level water tank at Mastung

Railway Station. It was full at the time of the earthquake, and must have swung like an inverted pendulum until it shot over to the south, turning upside down and crumpling up its iron supports. Another tank at the same station, which was empty at the time of the shock, was quite undamaged. The moral is to avoid heavy water tanks on the roofs of houses, or indeed any heavy weight, for it increases the period of oscillation of the structure, and the whole tends to swing in tune with the earthquake motion.

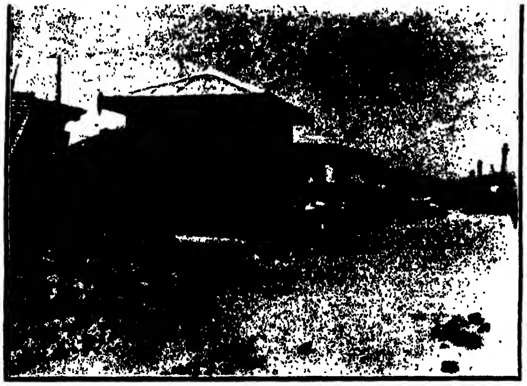

Fig. 3. A small compact building in the midst of the ruined city.

The Origin of Earthquakes

The orthodox view regarding the origin of earthquakes is to associate them with movement along a fault or fracture in the earth's crust. If one considers, however, the immense amount of energy that is released during an earthquake, one may well wonder whether such movement is sufficient to account for the observed phenomena. Dr. S. K. Banerji of the Meteorological Department has calculated that the energy released in the North Bihar earthquake was of the order of 10^{22} ergs. This may not convey much to the average reader, and may be put in another way. A Spanish seismologist, writing of the Japanese earthquake of 1911, calculated that the amount of energy released was equivalent to the energy produced by a 60,000 horse power engine running night and day for 35,000 years!

Another reason for doubting if earthquakes are caused by movement along a fault is the fact that many earthquakes seem to have had a fairly deep focus, too deep for the origin to have had any connection with faults in the sedimentary rocks of the surface crust. It is possibly more correct to regard the movement along faults, which has been noted in the case of a few earthquakes, as merely one of the superficial effects of the earthquake which may itself have been due to some much deeper seated cause.

The Prediction of Earthquakes

After the Tango earthquakes of 1927 it was found that the succeeding aftershocks were frequently preceded by a slight tilting of the ground, and a good deal of research work is now being done by the Earthquake Research Institute at Tokyo on this promising line of investigation. At present, though it is recognized that slight tilting of the ground may indicate instability, it is not yet possible to tell when an earthquake is going to occur.

As regards immediate warning advantage has sometimes been taken of the fact that animals perceive the beginning of a shock a little earlier than human beings. It seems that they are able to feel the preliminary tremors while they are still imperceptible to the ordinary person. The well known Japanese seismologist, the late Prof. Omori, used to keep a large number of pheasants in his garden, because it was known that the Japanese pheasant crows just before an earthquake. Since, however, the warning given is only of a second or so, and since

Fig. 4. Overturned water tank, Mastung Road Railway Station.

Japanese pheasants presumably crow at other times also, the value of this observation is a little doubtful.

Earthquake Research in India

In the investigation of earthquake phenomena India has in the past taken a leading part. It was R. D. Oldham of the Geological Survey of India, who first identified the three types of earthquake waves, preliminary, secondary, and surface, that are recorded on a seismograph—a work that has borne great fruit in investigations regarding the internal structure of the earth. The long period of comparative earthquake quiescence in India between 1905 and 1927 has no doubt been responsible for less interest having been taken of late in the scientific investigation of earthquakes in India and in associated problems, such as earthquake-proof construction. Now that attention has been aroused once more by the recent succession of severe earthquakes, it is to be hoped that this country may once again take its place in the forefront of seismological research. At the symposium on the North Bihar Earthquake, held at the meeting of the Indian Science Congress last January, Dr. Normand, Director-General of Observatories, expressed the hope that more interest might be taken in seismology by the physics departments of the universities and that some of the work which is being done on the constitution of the atom—work which is being carried out all over the world—should be diverted to the physical study of earthquakes in this country, which can only be done in India. This is a suggestion worth serious consideration. The National Institute of Sciences of India have recently represented to Government the urgent necessity of establishing more seismographs in different parts of India. If this is agreed to, there seems no reason why some of them should not be placed under the care of the physics departments of the universities, action which might well stimulate a period of active research into what is really one of the most pressing problems of the time, and the investigation of which might well lead up to the actual prediction of earthquakes, a consummation which would be one of the greatest scientific contributions ever made to the cause of human welfare.

The National Physical Laboratory and its Activities

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In every civilized country of the world, need has been felt at times for a laboratory where accurate tests of weights and measures used in the country, as well as standardization of meters of all kinds, (thermometers, gasometers, all kinds of electrical meters used in industry) can be carried out. To this must be added also scientific investigations of national and international importance which cannot be undertaken by private bodies or universities. France was the first in this field with her *Bureau des Standards et Mesures.* This Bureau is now supported by an international committee and it is known as Bureau International Poid et Mesures, and is located at Versailles. It was established during the French Revolution when the old weights and measures were discarded and the Metric System was adopted. The Bureau of Standards keeps the Platinum Bar which stands for the International Meter. Germany followed France after a long interval, when in 1883, as a result of the efforts of the celebrated Helmholtz, the Government of Prussia established three Standardizing Laboratories *viz.* the Physico-Technical Federal Institution at Charlottenburg (*physikalische-Technische Reichsanstalt*), the Chemico-Technical Federal Institution (*Chemische Technische Reichsanstalt* and the Biological Federal Institution. The U. S. followed in with her Bureau of Standards in Washington. The National Physical Laboratory of England which conducts work on the above mentioned lines came into existence in 1903. We need hardly add that the necessity for such a laboratory is very great; for at present we have not only to do with measures of length of solids and liquids and of their weights as our ancestors had, but with increasing industrialization and increasing consumption of gas and electricity, all kinds of meters have to be used by private persons, industries, and corporate bodies. But unfortunately in India there is no laboratory where these meters can be satisfactorily tested and standardized. It has been found that these meters are sometimes inaccurate and faulty, and the public undergoes a heavy loss on that account. It was once found, for instance, by the present writer that a standard gallon utilized by the municipality of a respectable city measured actually 10% less than one gallon and, as this municipality charged for water, the loss incurred by the public owing to the use of false meters may have run into lakhs of rupees. The same may be said of electrical meters supplied by supply companies. The Government sometimes maintains inspectors, and the instruments are tested in Test Houses, but the methods, for various reasons, do not inspire confidence. To settle disputes in the matter of meters there is no laboratory where meters thrust upon the public by the supply corporations can be tested. The materials for use of private or public bodies should also be put to test before use.

The National Physical Laboratory (N.P.L.) does all types of routine work for industries and for protection of the nation. An idea of the extended activities and importance of the N.P.L. will be gained from a brief account given below (1931).

It was in 1897 that the Treasury appointed a committee with the late Physicist Lord Rayleigh as chairman to consider and report upon the desirability of founding a public institution for standardizing, verifying, and testing materials and apparatus and for the determination of physical and chemical constants. The reports of the said committee being favourable, the Treasury invited the Royal Society to carry out the idea into practice; and a scheme of organization was quickly framed by the Royal Society

and approved by the Treasury. H. M. Queen Victoria made a grant in December 1900 of Busby House, Teddington for the use of the National Physical Laboratory. In 1918 a new scheme of control was framed, and as a result of it, the Executive Committee of the National Physical Laboratory became an independent body being composed of representatives of different scientific Associations, the Government and of Industrial interests. The President of the Royal Society is ex-officio the Chairman of the Executive Committee of the National Physical Laboratory.

Thus was the beginning of the National Physical Laboratory; since then it has added new departments under the supervision of the following Committees:—

(1) Research Committee.

(2) Electrical Units and Standards Committee.

(3) High Tension Committee.

(4) Committee for Metallurgical and Engineering Research Materials.

(5) Committee for Architectural Acoustics.

Broadly speaking each Committee represents the type of work which is conducted by the members of the staff of the National Physical Laboratory. The present strength is about 150 senior members who are all trained scientific men, and many are very eminent in their lines and in addition to them there are assistants, observers, mechanics etc. The present Director is Sir J. E. Petavel, K.B.E., D. Sc., F.R.S.

Work of the National Physical Laboratory Departments

The Physics Department

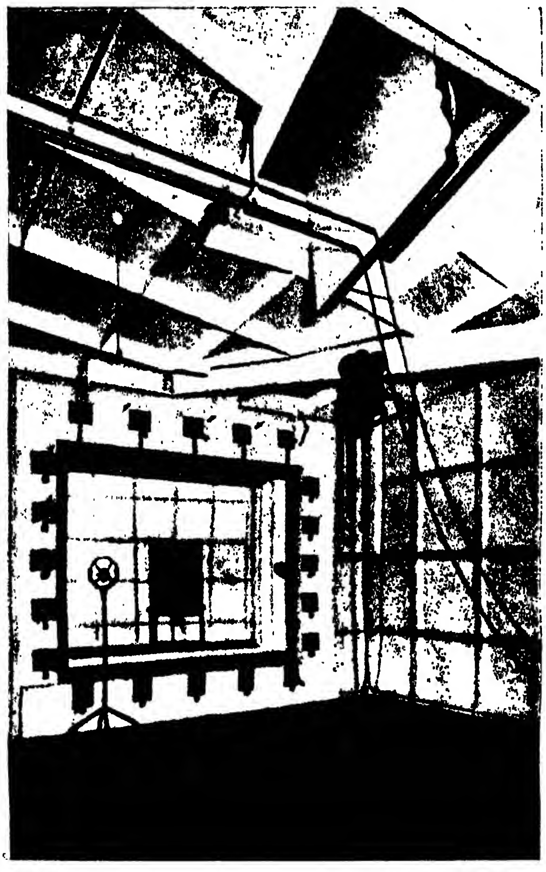
This department undertakes standardization work of all kinds of meters, Electrical Thermometers including those meant for measuring high and low temperatures. The instruments manufactured by any industrial firm are not recognized as standard, unless they get a certificate from the N. P. L. Besides, the members of the staff are given facilities for original research, and of important contributions made by the department. Mention might be made of the investigation of the ratio of specific heats which has resulted in the discovery that sound velocity increases with frequency when extremely high frequencies are used. To the Physics Department is attached the Food Investigation Board. Its work on the refrigeration and preservation of food of all kinds will be of interest to the public. It was realized, for instance, that the quality of meat and fruit kept in cold storage, as well as the amount of desiccation which might occur, depends considerably on the atmospheric humidity in the store. It was therefore necessary to undertake investigations for the measurement of humidity below

N. P. L. Tests for Clinical Thermometers.

zero degree Centigrade, and its control in the cold storage. This latter question necessitated investigations regarding the physical properties of the refrigerants, and the pipe linings of the store. The necessity for such a laboratory for India cannot be overemphasized, for India produces immense varieties of fruit as are not rivalled by any country in the world. But the fruit seasons are extremely short. During season time, fruits are in such plenty that a large percentage runs to waste, while outside

the season time, no fruits are available for consumption. With perfection of methods of preservation, such waste would be avoided and food problem will partly be solved.

The volume of test work on pyrometers has not shown any increase, while high-precision thermometer tests show an increase of 30% over the same in the year 1933. The number of clinical thermometers received for test during the year 1934 is about 410,000, and the percentage of rejections has slightly increased above 1·20%.



Test apparatus for measurement of Acoustic Isolating Values of Walls and Partitions.

The Radiology section has made a complete reorganization for X-ray diffraction test of crystals for testing materials. The work on Magnet Steel is in progress. It has been shown that the crystal structure associated with a good steel exhibits a marked degree of lattice distortion which is probably caused by interpenetration of the carbon of the steel into the lattice. "With the co-operation of the Research Associations of British Paint, Colour and Varnish manufactures, a detailed study of 'red lead' with special reference to its setting properties is in progress. At the request of the Medical Research Council further X-ray studies of the structure of the tooth enamel have been carried out. The work suggests that a classification of various types of enamel can be made, which depend upon the nature and extent of the fibre structure or selective crystal orientation which characterizes the enamel and distinguishes it crystallographically from the underlying dentine.

Sound

The report gives an account of the excellent facilities now provided by the section of the new Acoustics Laboratory which has been brought into active use during the current year. With the growth of industrial activity and popular interest on many acoustical problems, such as sound control in auditoria, planning of lecture theatre noise control, control of sound in factories, power houses and offices, the service of the laboratory has been frequently called for, specially by the Ministry of Health, of Transport, the Post Office, Railway Companies and many other public bodies including the Aeronautical Research Committee. Work on the isolation of air-borne sound, and transmission of sound through partitions are in progress. The technique for the tests and response of loud speakers, microphones, is being improved upon. Sound and noise meters developed by the department have found many fields of application. If such a testing laboratory existed in India, she would not have been afflicted with such monstrous engineering productions as the Council Chamber at Lucknow, or the Senate Hall of the Allahabad University.

Optics

In this department preliminary work on the construction of tables of values of aberration of lenses, standardization of "Day Light" lamps have been made. Work on the infra red spectrum and absorption bands of quartz and water vapour have revealed the so called "best form" of lenses as aid to vision.

Electricity Department

Electrical units such as units of current and resistance, inductance etc, have been determined with an accuracy of 2 parts in 10,000 by latest methods and every attempt is being made to push the accuracy further. Standards of "frequency" are maintained and tested from time to time. The N. P. L. is the place for reference on matters relating to all electrical units.

Photometry

This department has been recently added, and here all kinds of measurements relating to "candle power" of lights are done according to the latest methods with the aid of up-to-date apparatus. Motor car head lights, and the effect of glare on the retina, penetration of light through fogs, are some subjects of investigation of this department.

Radio Department

The Ionosphere in the upper part of our atmosphere contains large amount of electrically charged particles and reflect wireless waves. But for the existence of these particles, the radio waves would have been lost in space. There are several layers of these particles known as E and F_{12} layers. These layers are not fixed but vary with the time of the day and with the season and account for such phenomena as fading and other phenomena disturbing radio propagation. At the present time, investigations on the determination of the height of the layers and their charge have become matters of great importance, and in this country important works on this line are being carried under the direction of Prof. S. K. Mitra at Calcutta and Mr. G. R. Toshniwal at Allahabad. In the N. P. L. the development of semi-automatic means for sounding the Ionosphere has contributed to a rapidly advancing knowledge of the Ionosphere. Substantial progress has been made in the signal and receipt of short waves. One of the most important contribution of this department is the method developed by the department for "direction finding" by short waves with an accuracy of $\pm 1°$.

Metrology Department

This department maintains the Unit of length, the duplicate of the International Metre at Paris. Every year fresh measurements are taken and accuracy is also improved; for instance, the department is now busy in locating the source of difference of 5 parts in 10 millions between the wave length values for the Metre, *i. e.* number of wave lengths of the red cadmium line contained in the metre obtained by this department, and the same in Physikalische Technische Reichsanstalt, Berlin–Charlottenburg, and Bureau International Poid et Mesures at Versailles and Bureau of standards at Washington D. C.

Engineering Department

Of the investigations undertaken by the Engineering department the following may be mentioned:

(1) Lubricating value of Synthetic oils.
(2) Investigation on satisfactory pipe joints for high pressure and high temperature work.
(3) Corrosion of Metals.
(4) Design and Standardization of "lifting Gears."
(5) Hooks, rings etc.
(6) Mechanical properties of Welded Chains.

Metallurgy Department

(1) Study of molten metals.
(2) Study on the properties of light aluminium alloys, particularly of light alloys of magnesium, and aluminium, such as duraluminium, and magnelium largely used in aircraft.
(3) Properties of steel at high temperatures.
(4) Cracking of boiler plates in caustic solution.
(5) Gas cylinders under high pressure.

Aerodynamics Department

This is one of the most important departments of the National Physical Laboratory, and many important contributions and advances on the question relating to research work are conducted under the supervision of the Aeronautical Research Committee on behalf of the Air Ministry. During the year under review two important wind tunnels have been completed. The wind tunnel is one of the most important apparatus for aerodynamic research, and much of our knowledge regarding the forces on the aircraft has been obtained by

experiments and tests with models in wind tunnels. The model is suspended at rest, while a strong current of air produced by the suction of powerful blowers is made to move past it. In order to control the wind velocity and other necessary conditions it is necessary that the experimental air current be conducted along a wind tunnel. The newly completed high speed wind tunnel was greatly in demand for tests and research at velocities in the neighbourhood of sound velocity. Formerly England was behind Germany in this respect as the latter country possessed a fine wind tunnel in the aerodynamical observatory at Göttingen under the direction of Prof. Prandtl. Such questions as the air flow round bodies similar to the aeroplane, its wings and airscrews, the lift and drag on aerofoils etc. at such high speeds, can now be answered. The wind tunnel is one foot in diameter at its narrowest point and is therefore limited to the tests of experimental models of aeroplane. At a pressure of 60 pounds per square inch, the speed of the air flow becomes quite steady at about 975 feet per second (sound velocity 1100 feet per second). The study of the behaviour of six aerofoil sections in common use in the wind tunnel experiments and a comparison of test on a model of "Parasol" machine with results obtained in actual flight have shown agreement.

Work on the flow of fluids continues. Measurements of turbulence taken with the help of Hot Wire' anemometer and Ultra microscope—a new method that has been lately devised for the purpose—show close agreements. The "Schlieren" method for measuring turbulence has also been used for the last three years and modifications have been introduced for photographing the eddies with the aid of the photoelectric cell.

Researches on the stability and control of aeroplane have been continued. Experimental results show that in "*stalled* flight" some of the stability derivatives exhibit very peculiar variations which could never have been predicted from wind tunnel experiments. Attention has also been given to the problem of landing of air craft. Modern design has led to aircraft of very low drag, which glide into land at a *fine* angle and take rather long to lose their speed and come to rest. It has accordingly been found necessary to fit devices, such as flaps, which deliberately spoil the good aerodynamical qualities of the machine when taking a landing. Tests of landing flaps have been carried out in wind tunnels, and calculations have been carried out to compare the landing qualities of machines with various devices of this kind and the enormous saving in landing space which these devices render possible.

The William Froude Laboratory

Sir William Froude was the founder of the method known after his name by which the resistance of the ship during motion, and its propulsion and such other kindred questions can be answered. It consists in making a model ship with wax and then towing it in a tank and making the requisite observations. This laboratory is named after him and researches on the above mentioned lines are conducted under the supervision of the superintendent G. S. Baker, O. B. E. To meet the increasing demand for tests and research a new tank known as the Yarrow Tank (the cost of installation of which has been defrayed by the great ship-magnate Mr. A. F. Yarrow) has been constructed, and during the last months of the year under review, continuous overtime work in the evening has been necessary. The laboratory also undertakes tests of ships already built. These are tested with propellers and stern fittings. In

Complete Lithgow Propeller Tunnel.

some cases modifications were suggested in order to improve the power required for propulsion. In the year 1933 about 60 designs of ships were tested, of which not less than 54 were modified; the modifica-

tions effect a gain of about £ 25,000 in the annual running expense of ships—the figure for a single year being considerably in excess of the total annual cost of running the William Froude Laboratory. Of the Research work of the Froude Laboratory the following will give some idea :—

(1) Screw Propellers with Model *Coasters*.

(2) Approximate Ship length for minimum pitching and maximum sea-worthiness.

(3) Wave Resistance.

(4) The effects of stream line film upon the efficiency of ship propulsion.

Lithgow Propeller Tunnel

The erection of the new propeller tunnel has been completed in 1934. There was a great demand for a propeller Tunnel on account of increase of Screw Propeller Research. The Lithgow Propeller Tunnel is fitted with the most up-to-date single screw testing apparatus. The tunnel is vacuum tight and shows, when full of water, an increase of pressure from 1″ to 15″ of mercury in 85 hours during which the experimental Propeller was in position.

Lectures

Lectures were also delivered by the members of the staff at a number of provincial centres, which were highly appreciated—engineering and metallurgical subjects at Birmingham, Leeds, Manchester etc : Aerodynamics at Cambridge, Chelmsford etc : Acoustics and measuremants of Noise at Bangor, Oxford etc.

Gifts and Donations

The National Physical Laboratory received a total sum of £ 3614/15/-from various Associations and persons, but its expenses are mainly borne by the state.

Nuclear Physics

Papers and Discussions on Nuclear Physics—*Organized by the International Conference on Physics (London 1934). Published by the Physical Society, London, 1935.*

An International Conference on Physics was organized by the International Union of Pure and Applied Physics and the Physical Society of London, and about 200 distinguished physicists were invited to take part in it.

The Conference divided itself into two sections, one on Nuclear Physics and the other on the Solid state of Matter. The volume under review contains a report of the papers on Nuclear Physics read before the Conference, with contributions to the discussions made either at the meetings or communicated subsequently. This volume forms the first authoritative exposition of the subject by recognized experts, appearing in the English language.

After an address of welcome to the delegates delivered by Sir F. G. Hopkins, President of the Royal Society, Lord Rutherford gave a brief survey of the subject of Nuclear Physics, which contains a very lucid account of the origin and development of our present day knowledge of the physics of the atomic nuclei.

This is followed by a paper on Quantum Electrodynamics by Prof. Max Born, summarizing the the contents of several publications by himself and Infeld, in which the idea of a unitary field theory has been formulated. Starting from the assumption that it is possible to find a single electromagnetic field which will satisfy a modified type of Maxwell equations, and also describe simultaneously the motion of all types of particles (electrons, protons, neutrons and neutrinos) in conformity with the principles of quantum theory, a new set of field equation is proposed in which the electric and the magnetic vectors are expressed in units of an absolute field and they are shown to be invariant to general transformations.

After these preliminary reports comes the discussion of some of the outstanding problems of Nuclear Physics which are grouped under four general sections :—

(1) Natural β-decay.

(2) Artificial radio-activity.

(3) Disintegration and syntheses of nuclei and elementary particles.

(4) Cosmic radiation.

A summary of the papers which have appeared in these four sections is given below :—

Natural β-decay.

It is known from the study of the energy spectrum of the α and γ rays emitted by radioactive nuclei, and from the study of the hyperfine structure of spectrum lines that the atomic nuclei exist only in discrete quantum states, and the energy of particle and radiations emitted by them can be represented as due to transition between such quantized states. One of the outstanding problems of radioactive transformation, which await a satisfactory solution, is the fact that the β-ray spectrum emitted by a radioactive nucleus is a continuous one with a sharp upper energy limit.

Beck in his report on theoretical consideration on the radioactive β-decay summarizes the theoretical problem and discusses the neutrino hypothesis which was put forward by Pauli and worked out quantitatively by Fermi. According to this theory, simultaneously with the emission of β-particles another particle called neutrino (of small mass, no charge, and spin $\frac{1}{2}\frac{h}{2\pi}$) is emitted, by means of which the conservation of energy, momentum and spin in the nuclear transformation is maintained. Beck himself has given an alternative hypothesis, in which the second particle is a positive or negative electron which is subsequently captured by the nucleus.

C. D. Ellis in "The β-ray type of radioactive disintegration" gives a summary of the experimental investigations on the β-ray disintegration of elements belonging to the thorium and the radium series, and makes a detailed comparison with the prediction of Fermi's theory. The mass of neutrino which is not specified in the above theory comes out, from a consideration of Henderson's recent investigations, to be zero or at most a value many times less than that of an electron.

This is followed by a report by Gamow on the General Stability Problems of Atomic Nuclei. Starting from Heisenberg's theory of the building up of atomic nuclei by means of protons and neutrons, he discusses the condition under which the different kinds of particles will be emitted by an unstable nucleus. According to Gamow, considerations of symmetry and also certain experimental observations lead to the conclusion that negative protons can also exist in the nucleus. In the discussion which followed, Prof. Fermi, while arguing with Gamow on the possibility of the existence of negative proton, pointed out some of the difficulties of this view point, which are chiefly connected with the interpretation of the fact that the atomic weights are approximately equal to twice the atomic number.

Artificial Radioactivity

The next two sections deal with the transformations which take place in stable nuclei under the action of fast moving material particles like α-particles, protons, neutrons, and deutons and also by hard γ-rays. In all these cases the bombarding material particles enter into the nucleus. The change which takes place in the transformed nucleus has been studied from two different standpoints :

(*i*) Instantaneous breakdown of the nucleus with the ejection of an α-particle, proton etc. depending on the nature of the nucleus and of the incident particle ; and (*ii*) the transformed nucleus acquires an instability and breaks down gradually within a definite life period with the emission of charged particles and radiation. This phenomenon is known as artificial radioactivity and has been dealt in papers by Fermi and Curie Joliot.

Fermi in his article on artificial radioactivity produced by neutron bombardment has given a summary of his well known investigations on this subject. To explain the observed changes he assumes that the first stage of the process is the capture of a neutron which is followed by the emission of a quantum of γ radiation, a proton or an α-particle. The first stage presents no theoretical difficulties, but the subsequent ejection is not easy to understand. The theoretical difficulties presented have been briefly discussed.

Curie and Joliot in their article give an account of their discovery of artificial radioactivity which they observed first when aluminium was bombarded by α-particle of Polonium. From the observation that ${}_5B^{10}$ can be transformed into ${}_6C^{12}$ by two different processes one of which involves the emission of a neutron, they have calculated the mass of the latter and found it to be 1.0098, while Chadwick and Goldhaber find it to be 1.0080.

Disintegration and Syntheses of Nuclei and Elementary Particles

Bethe and Peirels in 'Photoelectric Disintegration of the Diplon' have considered from a theoretical standpoint the problem of photoelectric disintegration of the diplon and other allied particles.

Chadwick and Feather in their article on Neuclear transformations produced by α-particles and neutron remark that owing to the existence of nuclear potential barriers only light elements can be disrupted by collision with α-particles. They have discussed the different types of interaction which can take place between an α-particle and a nucleus, and give illustrations of these from their own investigations and those of others. They have also reported on the disintegrations of some of the lighter atoms by neutrons.

Cockroft gives an account of the disintegration of some of the lighter elements like Boron, Carbon, Oxygen etc. under the bombardment of high speed protons and deutons. The nature and the energy of the emitted particle are dealt with in detail and the height of the potential barrier of some of the lighter elements is given.

Oliphant reports on the transformation of the two lithium isotopes, boron and heavy hydrogen, under the bombardment by protons and diplons. In the case of bombardment of heavy hydrogen by diplons it is shown that probably two new isotopes, one of hydrogen $_1H^3$ and the other of helium $_2He^3$, are produced.

Lauritsen and Crane have reported on the result of their investigations on the γ-rays from artificially produced nuclear transformations. They have used proton and deuton streams accelerated through a potential drop of 0.9 m.e. V. to bombard some of the lighter elements and have studied the properties of the γ-rays which are emitted during the nuclear transformations. A list of the excitation levels which have been derived from a study of the γ-ray emission from these light nuclei are given, and these include evidence for one and possibly two excitation levels in the α-particle.

Cosmic Radiations

The above three sections deal with the problems of nuclear disintegration and the radiation emitted due to impact of nuclei with high speed particles and hard γ-rays. The latter are either due to the radiations emitted by radioactive elements or are produced artificially. The study of cosmic radiations have brought before us other sources of still more highly penetrating radiations which are again very effective sources of nuclear disintegration. It is now known that these radiations at sea level consist at least of three different constituents, *viz.*, (1) a very penetrating radiation of charged particles, whether electronic or photonic in character, which has not yet been definitely established, (2) softer particle radiations both positrons and negatrons, (3) shower producing rays which are supposed to be photonic in character. In addition, Hoffmann and others think that there is a fourth kind which is responsible for producing what are called "ionization bursts". The relative proportion of these constituent radiations at different altitudes and magnetic latitudes and their mutual relations have been described in a number of papers in this section.

Anderson and Neddermeyer in "Fundamental Process in the absorption of cosmic ray electrons and protons", give a remarkable series of photographs of cosmic ray tracks in Wilson Chamber. These authors find that some of the very penetrating particles suffer loss of energy of the order of 100 m.e. V. per cm. of lead which is not accompanied by any secondary ionization and they naturally suggest that this energy is probably transformed into photons which are responsible for shower productions.

The latitude effect, *viz.*, the sorting out of the softer component of the cosmic rays by the earth's magnetic field, between the magnetic latitudes 45° N and 38° S, has been reported by Auger and Leprince-Ringuet. Also an east-west asymmetry has been observed which indicates a preponderance of positively charged particles in the cosmic radiation. The authors also have made some high altitude measurements at *Jung frau jock* (3500 metres) and the relative proportion of the soft and hard components of the cosmic rays at this altitude and at sea level has been compared.

Bowen, Millikan, and Neher give an account of a high altitude survey of the latitude effect upon cosmic ray intensities. They interpret their results on the hypothesis prepared by Millikan that the only source of cosmic ray energies is matter annihilation and the temperature conditions under which such annihilation can take place have been discussed. Cosmic ray bursts have been reported by Compton and Bennet at different altitudes; some of these bursts produce 2×10^5 ions, thus confirming the observations first made by Hoffmann. They show that such bursts have been measured when the electric potential across the ionization chamber containing Argon is as low as 18 volts and thus negativating the hypothesis that these bursts are due to ionization by collision inside the chamber. Hoffmann also gives an account of this phenomenon as observed originally by him and discusses the various suggestions made to account for this phenomenon.

Blackett gives a general report on the absorption of cosmic rays in which the experimental data and the theoretical interpretations are discussed.

Rossi gives a valuable report of his investigations on cosmic rays at different altitudes and latitudes and discuss some of the conclusions as to the nature of the different constituents of the cosmic rays.

H. P. Dey.

Influence of Light in the Nitrogen Cycle in the Soil

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The influence of sunlight and artificial light on the growth and activity of plants has been investigated since the middle of the 18th century. In 1770, the Dutch physician Ingenhousz reported that the carbon dioxide of the air combines with the water vapour and produces food materials in the plant aided by the sunlight. The food material formed in the plant supplies nutrition to the animal body and in this process of assimilation by animals, the food stuff is converted into CO_2 and water with liberation of energy, which is utilized by the animals. The carbon dioxide and water set free by the animal kingdom are utilized by the plants with the help of sunlight for the formation of food materials. These two processes are reversible.

$$6CO_2 + 6H_2O + E \rightleftharpoons 6C_6H_{12}O_6$$

and can go on simultaneously and thus the constancy in the ratio of the carbon dioxide and oxygen is maintained in the atmosphere.

Since the time of Ingenhousz, botanists, physiologists, chemists and agriculturists have carried on a large amount of scientific work on the influence of light on plant processes and we know a good deal about the mechanism of the formation of food materials in the plants through the agency of sunlight.

In recent years, the influence of light on human beings and animals is being investigated scientifically. There is no doubt that rickets, cancer, and several other diseases are less frequent in tropical countries than in temperate climates although the food of the tropical people is, as a rule, inferior to that partaken of by the inhabitants of most of the temperate climates. It is now generally admitted that rickets, cancer and several metabolism diseases are avoided by light absorption.

The influence of light on soil, however, has not yet been scientifically studied.

As practical men, the farmers of India and Egypt realized long ago that the baking heat of the sun is good for the soil and exposure of the soil to sunlight is an ancient practice still common in India and Egypt.

What is the function of light in improving the soil? In order to answer this question scientifically, a large amount of work has been carried on in the Chemistry laboratories of the Allahabad University, and it has been observed that sunlight plays a very important rôle in the nitrogen cycle in the soil.

The Royal Commission on Agriculture in India (1928) reported that the Indian soils are mainly deficient in combined nitrogen and the manurial problem in India is in the main one of nitrogen deficiency. It is a well established fact that for the healthy growth of a plant and a proper yield of crop nitrogen compounds or combined nitrogen must be supplied to the soil. Just as animals require nitrogen compounds for their existence the plants should also be fed with nitrogenous materials. The uncombined nitrogen present in the air is not directly absorbed by the majority of the plants. In European and more advanced countries of the world, ammonium salts, urea, nitrates, cyanamide etc. are supplied to the soil as manures for improving the crop yield. All these compounds form ammonium salts in the soil. The advanced nations are competing with each other in the manufacture of ammonium salts and nitric acid by the combination of the Haber-Bosch and Ostwald processes and it is no exaggeration to state that the standard of civilization of a country can be judged by the amount of nitrogen of the air fixed or the production of synthetic ammonia from the nitrogen of the air, just as in the past the amount of sulphuric acid or soap consumed formed a basis of the standard of a country. The addition of ammonium salts to the soil largely improves the yield of crops and under favourable conditions the yield can be

doubled *e. g.* in Belgium the yield of wheat per acre is double that obtained in India.

In our country not a single firm exists for the fixation of the nitrogen of the air and naturally ammonium salts manufactured in other countries have to be used for our soil ; but the Indian peasant is too poor to utilize the imported and costly ammonium salts. They utilize farm yard manure (cow dung), oilcakes, green manure etc. All these substances contain protein or complex nitrogenous compounds. The proteins supplied to the soil with manure are first converted into ammonium salts which in their turn combine with the oxygen of the air present in the soil forming nitrites. The nitrites are also oxidized (combine with oxygen of the air) to nitrates, which are the real nitrogenous plant food material. The plants absorb nitrates from the soil and utilize them for the building of proteins or nitrogenous compounds in their bodies. Ammonium salts very seldom, and nitrites not at all, are used up by plants. The carbohydrates, or substances like starch, sugars etc. which are formed in the plants from carbonic acid and sunlight combine with the nitrates absorbed by plants and form amino acids which are the precursors of proteins. The amino acids first formed in the plants condense into proteins. Recent experiments carried on here show that in presence of sunlight carbohydrates and nitrates (but not ammonium salts) form amino acids and ammonium salts artificially in glass vessels *(in vitro)*.

The production of ammonium salts from proteins, the oxidation of ammonium salts to nitrites, and the formation of nitrates by the oxidation of nitrites in the soil, have been recognized to be distinct chemical changes, which are generally believed to be due to the influence of the bacteria and other micro organisms present in the soil. Our researches show, however, that proteins can be converted into ammonium salts and ammonium salts can be oxidized to nitrites and nitrites to nitrates when exposed to light and air *in the complete absence of bacteria or any micro organism*. This observation explains why exposure to sunlight does good to the soil, because plants require nitrates for their growth and the formation of nitrates is facilitated by sunlight. This conclusion that sunlight is beneficial in the formation of nitrate in the soil has been supported by Dr. A. S. Corbet working at the Agricultural Research Station under the Imperial Industries at Jealott's Hill, England, Dr. O. N. Allen of the University of Hawaii, Dr. Sarkaria and Fazal Uddin at Lyallpur and by others. It will be interesting to note that the bacteria present in the soil of temperate climates can work best at 25°C whilst the bacteria existing in the soil of our country have their optimum conditions of activity not at 25°C as in temperate climates but at 35°C.

It appears, therefore that like tropical man, the tropical bacteria are used to a higher temperature. Experiments carried on at Pusa, Allahabad, Lyallpur and in Egypt show that the soil temperature even upto a depth of 9 inches exceeds 50°C in the months of April, May and June. At this temperature most of the bacteria are actually killed or rendered inactive and that is why Dr. Corbet reported that the number of bacteria present in the Malayan soil is much less than that present in the soil at Rothamstead, England. It is surprising however, that although the bacteria are inactivated by the extreme heat prevalent in the summer months in the tropical countries, the nitrate content of the soil is maximum in the summer. This fact has to be explained from the view point that the sun is a more powerful agency in the formation of nitrates in the soil than bacteria.

From the practical and industrial point of view, the utilization of molasses is a very big problem. The rapid expansion of the Indian Sugar Industry has increased the production of molasses to a great extent. It is estimated that the output of molasses from the sugar factories in India is approximately 500,000 tons per annum. Practically the whole of this amount of molasses is being wasted at the present moment. The Indian sugar industry is therefore faced with the difficult problem of the utilization of this bye-product.

The experiments carried on here show conclusively that the combined nitrogen, that is, the most important substances necessary for plant growth *e. g.* ammonium salts and nitrates are considerably increased when molasses, the waste product of sugar factories in India, are added to the soil and the soil well ploughed. It is well known that

the molasses contain a large percentage of carbohydrates. How is that the addition of carbohydrates to the soil increases its combined nitrogen content? Just as carbohydrates on combination with the oxygen of the air supplies energy to the animals, the oxidation of the carbohydrates added to the soil with molasses sets free energy which is utilized in the combination of nitrogen and oxygen present in the soil leading to the formation of nitrates. The generation of nitrates from air requires energy, which is supplied to the soil by the oxidation of the carbohydrates added with molasses. The nitrates formed in this way on the addition of molasses to the soil which has been well ploughed, react with the carbohydrates with the formation of ammonium salts and traces of amino acids and that is why increase in the amounts of the ammonium salts is readily detected on the addition of molasses to the soil which has been well ploughed. The ammonium salts thus formed in the soil are exposed to light and air and form nitrates by light absorption. And thus the most important nitrogenous compound necessary for the plant growth *i.e.* nitrate is added to the soil when molasses are used as manure.

Researches carried on here show that the amount of molasses varying from 90—270 maunds per acre of soil when added after mixing with water produce beneficial results in increasing the yield of crop in the case of rice, wheat, sugarcane etc. Molasses should always be added to the soil 2 to 3 months before the sowing of the crop and the soil well ploughed after the addition of molasses. It is more difficult to obtain any good out of molasses when added to the growing crop or plant. The results obtained in the Shahjahanpur Government farm show that the yield of sugarcane is increased by 36% when molasses are added to the soil before the planting of sugarcane, but no increased yield is observed when molasses are added to the growing plant.

Molasses as fertilizers for improving the crop yield are being utilized by some tea estates in Assam, in several farms in Bihar, United Provinces, Bengal and Madras under the guidance of the writer. He is also in correspondence with several sugar manufacturers and sugarcane producers in Java for supplying instructions for the utilization of molasses as manure.

Many workers have failed to obtain nitrogen fixation in soil by the addition of molasses. Our experiments show that the failure is mainly due to the insufficiency of aeration which results from inefficient ploughing of the soil. When the aeration is incomplete nitrogen fixation becomes defective, because energy is necessary for nitrogen fixation and this energy comes from the oxidation of the carbohydrates present in the molasses. If this oxidation is defective due to lack of air, the amount of nitrogen fixed will also be less.

Following the lead of the immortal French chemist, Louis Pasteur, perhaps the greatest benefactor of humanity, his disciples, notably, S. Winogradsky and others, taught that the fixation of nitrogen in the soil can only take place through the agency of living bacteria. But the researches carried on by the writer and his colleagues, notably Drs. C. C. Palit, A. K. Bhattacharya, Gopala Rao, Mr. N. N. Biswas, Mr. S. P. Tandon, Mr. S. K. Mukerjee, and E. V. Seshacharyulu, have definitely established that the fixation of nitrogen in the addition of ammonia to the soil can take place in the complete absence of bacteria provided the carbohydrates are oxidized through the agency of sunlight and chemical catalysts like compounds of iron, titanium, manganese, copper etc.

When 50 gms of soil sterilized by heating it to 200°C for $2\frac{1}{2}$ hours are mixed with a sterilized solution of cane sugar containing two gms of cane sugar and exposed to sunlight in a quartz (silica) flask for 150 hours under completely sterilized conditions, the ammoniacal nitrogen rose from 0.00155% to 0.0056%. Exactly similar results were obtained with other experiments carried on with sterilized soil and cane sugar exposed to light in quartz vessels. Experiments carried on in dishes show that when cane sugar or molasses are added to the soil which is properly aerated the amount of ammonia goes on increasing up to a limiting value and that on exposure to light the nitrate content also increases with time, specially in aerated soil. When the exposure is continued further loss of nitrogen sets in, due to the formation and decomposition of the unstable substance, ammonium nitrite. A far reaching conclusion can be drawn from

these experiments that, under identical conditions, the amount of ammoniacal nitrogen is always greater in the unsterilized soil mixed with carbohydrates and receiving sunlight thah in the vessels kept in the dark. If this type of nitrogen fixation had been entirely a bacterial process as has been generally believed, the amount of ammonia formed should not differ in the vessel kept in light or in the dark. It seems therefore established that just as bacteria can fix nitrogen in the soil in the presence of energy-rich compounds, similarly, even in the absence of bacteria, the oxidation of energy-rich compounds, *e. g.* carbohydrates, by the agency of light or chemical catalysts, leads to the liberation of energy which is used up in the fixation of atmospheric nitrogen in the soil. It appears, therefore, that in tropical countries in ordinary soils, the fixation of atmospheric nitrogen by the addition of energy-rich compounds is partially bacterial and partially photochemical. The oxidation of energy-rich organic compounds added with the molasses, either by light absorption or by bacterial action, causes the fixation of atmospheric nitrogen in the soil.

Numerous experiments on the estimation of the ammonia content of the soil before and after the addition of molasses show that the ammonia content of the soil is 3 times greater after the addition of molasses than that originally present in the soil.

Moreover, recent researches carried on here prove that molasses, when mixed with soil, also help in the conservation of the nitrogenous compounds present in the soil. Experiments show that the loss of nitrogen from the soil on adding large amounts of nitrogenous compounds to the soil is greatly decreased when, along with the nitrogenous compounds, molasses or other carbonaceous compounds are also put in.

The following lines from Russell's *Soil Condition and Plant growth, 1932*, show that different results have been obtained by different investigators regarding the value of sugars in increasing soil fertility, and incontestable proof for the fixation of nitrogen on the addition of sugars to the soil is still lacking. "Increased yields of sugar cane followed the application of molasses to soil at the Station agronomique and on Mr. Ebbel's Estate at Mauritius, where the residual effect is well shown, and also in Antigua; Peck, in Hawaii, on the other hand, observed marked losses of nitrate, as also did Harrison in British Guiana". "Laboratory investigations in humid climates suffer from the difficulty that the soils already contain so much nitrogen that small changes are difficult to measure accurately, and there are losses of nitrogen which counterbalance any fixation. Investigation would be easier in some of the soils, very poor in nitrogen, found in hot, arid conditions. Rigid incontestable proof could be furnished only by a demonstrated gain in nitrogen effected by Azotobacter, all other possibilities being ruled out." Exactly similar views have been expressed by S. A. Waksman in his *Microbiology of Soils.*

It is interesting to note here that previous workers in this field determined only the total nitrogen of the soil after the addition of energy-rich compounds, and as the difference in the total nitrogen is not high before and after the addition of the energy-rich compounds to the soil, they were doubtful regarding the fixation of nitrogen in the soil by the addition of energy-rich compounds. But as in our experiments the available nitrogen (ammoniacal and nitrate nitrogen) and the total nitrogen have been estimated, we have been able to detect the increase of available nitrogen in all cases when energy-rich organic compounds (carbohydrates) are added to well-aerated soils. Hence, molasses, the waste product of Indian sugar factories, when added to the soil will conserve and also add combined nitrogen to the Indian soil which has been pronounced to be deficient in it.

It appears that sunlight plays an important rôle in many oxidation processes taking place in the soil and that chemical and photochemical agencies may also be active in the nitrogen cycle in the soil. In this connection the following observation of Dr. A. S. Corbet is of interest :—"It seems evident that the fall in the nitrogen content of the soil to a lower level on subjection to higher temperatures must be ascribed to chemical and not to microbiological agency."

Book Review

Heredity and the Ascent of Man.—*By C. C. Hurst, Cambridge University Press. 3/6.*

This small volume is an epitome of the author's larger work, *The Mechanism of Creative Evolution*, published in 1932, and is written mainly for the general reader rather than for a serious student of biology. The author starts with a description of those fundamental units of life and mind which determine the nature and behaviour of all living organisms, starting from the ultra-microscopic living creatures which can pass through the finest filters, and culminating in the greatly evolved and highly intellectual Man.

The age of the earth as a planet is computed in round numbers at two thousand million years. With the present state of knowledge it is also believed that "matter had a solitary reign on earth of nearly a thousand million years before life appeared on the scene." It is thus clear that the origin of life was "approximately half-way between the origin of earth, as a planet thrown off from the sun, and the present time." In the work under review the author depicts a fascinating store of the evolution of the ultra-microscopic organisms since their first origin, and briefly deals with the origin of different species of plants and animals. In connection with the origin of life special reference is made to genes. They are ultra-microscopic structures found in the chromosomes of living cells resembling molecules in their structure, but differing from the latter in having "the power to grow by utilizing the matter around them", and being able "to reproduce themselves and to mutate." These genes are, in view of the recent work, believed to direct "the chemical reactions which give rise to all the organ and function" of living individuals. The author discusses in fair detail the genetical researches of the last decade, and is of opinion that this work may give freedom and power to man to shape his own destiny, particularly in reference to "the creative evolution of the mind, far surpassing and transcending the present conceptual and deterministic intellect of man."

B. P.

The Solid State of Matter—*Published by the Physical Society, London, 1935).*

The papers and discussions of the International Conference on Physics held last October in London have lately been published in two volumes of which the Solid State of Matter is one.

The papers are arranged in three sections : (1) the structure of molecules and of the ideal lattice ; (2) the deviation of the real crystals from the ideal lattice structure ; (3) plasticity and strain hardening in crystals, which follows the opening survey by Sir W. M. Bragg, who explains in general terms the significance of the advances that are being made in different directions of the subject. The first section contains three papers, the first of which deals with the problem of the constitutions and properties of aromatic and unsaturated molecules where Hückel gives a quantum theoretical basis to the hypothesis that valency forces in a molecule have a definite direction and also a quantum-theoretical interpretation of the binding conditions peculiar to aromatic compounds. Hund then gives a description of the binding forces in molecules and crystal lattices on the basis of the quantum theory, and points out our present inability to calculate the particular type of binding which Nature will choose for a particular case. Hund's paper is followed by Robertson's in which are tabulated the results of experimental measurements on atomic distances by the X-ray method in the case of diamond, graphite, and a number of organic compounds.

Of the six papers contained in section 2 the first one by Ewald and Reninger gives an account of experimental work on crystals of rock salt from

which it is concluded that the mosaic structure is a property of individual crystals, and is not of necessity shared by all crystals of a given substance. Goetz gives arguments in favour of postulating the existence in crystals of some kind of superstructure (called by him "group") which he supposes to consist of an agglomeration of a limited number of molecules in crystalline array, inside which the stability of a molecule is different from that outside. In explaining the large discrepancy between the theoretical and observed values of tensile strength of materials the existence of (a) internal faults and (b) surface crevices is generally invoked. In the next two papers Joffé reaches the conclusion that the practical weakness is due essentially to the sharp discontinuities present on the surface. Orowan points out that an explanation of technical tensile strength is not possible on the hypothesis of secondary or block structure. The section concludes with a paper by Smekal who gives an account of the structure-sensitive properties of salt crystals, as model of which is taken an ideal lattice crystal modified by the presence of "primary" and "secondary" flaws. The primary flaws are characterized by their amicroscopic dimension and owe their origin to the molecular character of crystal growth which gives rise to gaps and to local variations in orientation. Secondary flaws are those which result from the alteration of the primary flaws, or from the formation of new flaws in the solid state by mechanical or thermal treatment of crystals. They may reach much bigger size than the primary ones. The photochemical colorations, macroscopic cohesion, and elastic limit of rock salt crystals are discussed on this basis.

The last section contains two papers, one by Burgers and the other by Schmidt. Burgers gives a review of an extensive series of investigations on the deformation and recrystallization of aluminium crystals, followed by an appendix dealing with transformation hardening, which occurs on transition of one phase of a solid metal into another. Schmidt devotes himself largely to summarizing experimental data on crystal plasticity, where it is pointed out that Cauchy's relations are in general obeyed by ionic but not by metallic crystals. The final section of his paper deals with those types of plasticity which show no definite relation to the net-planes of the lattice.

All the sections are followed by long discussions in which a large number of physicists have taken part.

The publication thus gives us an admirable account of the various problems connected with the solid state of matter and indicates the lines along which they are being tackled.

D. P. R. C.

Experimental Physics, a selection of experiments—*by G. F. C. Searle, Sc. D., F. R. S. pp XIV+363. Cambridge University Press. 1934. 16s net.*

Dr. Searle is well known in the scientific world as an author and experimenter. The other books written by him are *Experimental Elasticity*, *Experimental Harmonic Motion*, and *Experimental Optics*, in all of which he has described with theoretical and practical details experiments mostly carried out in the Cavendish Laboratory under his guidance. The examples have been drawn from actual experiments performed either by him or by his students. He has worthily served the Cavendish Laboratory for a considerable number of years and this long association with a place which has been the nursery of great scientists and haven of eminent discoveries adds to the useful and instructive nature of his books. He will retire on the 30th september, 1935, to enjoy his well-earned rest and by way of a parting gift to his students and to those who will follow he has written the present volume entitled *Experimental Physics*. In this book as in others one does not fail to note his skill in devising experiments and designing apparatus thereof to test the validity of theoretical principles. A description of such experiments is not to be found generally in the existing books on Practical Physics.

This book comprises treatment of experiments in Dynamics, Elasticity, Surface Tension, Viscosity, Heat, and Sound. A chapter has been devoted to the stroboscopic method of determining the frequency of alternating currents. In Heat, the author has given only experiments on conduction through solids with a mathematical discussion thereon, mechanical

equivalent of heat and correction due to the emergent column of a mercury thermometer. In Sound, the subject matter consists of the theoretical calculation of the velocity of plane waves, mathematical treatment of spherical waves and radiation of energy and the theory of resonators followed by a few experiments connected with the latter. The subjects of Surface Tension and Viscosity cover three chapters and have been dealt with in great detail both theoretically and experimentally. The two chapters on Elasticity are like a supplement to the author's *Experimental Elasticity*. Lastly, in the chapter on Dynamics the author has given the theory and experiments on Kater's pendulum, recording gyroscope, moment of inertia about a non-principal axis, and the principle of the conservation of angular momentum. One feels, however, the entire exclusion of experiments of Electricity and Magnetism, for their inclusion would have justified the title of the book. It is to be earnestly hoped that in his leisure Dr. Searle will write another book on Experimental Electricity and Magnetism to complete his works.

B. C. Das.

Earthquake shocks recorded by the Seismographs at Alipore Observatory in August, 1935

Date	Time of beginning I. S. T. H.	M.	S.	Intensity	Epicentral distance (miles)	Remarks
1. 8. 35	19	43	52	Slight	2,890	Appears to have occurred near north of Sumatra.
3. 8. 35	6	44	35	Great	1,430	
"	13	21	36	Tremor	—	
"	17	24	27	Slight	3,270	
"	18	55	34	"	660	
"	19	44	6	"	580	
11. 8. 35	14	31	44	Tremor	—	
17. 8. 35	7	27	56	Moderate	5,780	
"	19	20	26	Tremor	—	
18. 8. 35	2	8	30	"	—	
23. 8 35	19	33	59	Moderate	1,980	Appears to have occurred in Sumatra.
24. 8. 35	0	6	39	Slight	280	Reported to have been felt at Muzaffarpur, Bhagalpur, Darbhanga, Samastipur, Sitamari & Motihari.
25. 8. 35	10	51	33	"	3,940	
26. 8. 35	22	16	38	Tremor	—	
27. 8. 35	11	6	50	"	—	
31. 8. 35	23	1	17	Slight	7,610	

The Need for Crop-Planning

J. C. Ghosh

Professor of Chemistry, Dacca University, Dacca.

[Note :—In this article Prof. J. C. Ghosh of the Dacca University has put forward certain very thoughtful suggestions regarding crop planning for Bengal. Dr. Ghosh's wide knowledge of the agricultural conditions in Bengal and of the application of scientific and also his long connection with the Agricultural Research Council make these suggestions doubly valuable, and should, we think, be carefully considered by the officials, zemindars, and peasants of Bengal.

The province of Bengal, as at present constituted, is mainly dependent on agriculture. According to Sir William Willcocks, her soil is as fertile as that of Egypt, and she should be as prosperous as Egypt. But the discrepancy between the two countries can be easily gauged from the following illustration. The area under cultivation in Egypt is equal to that of the Presidency Division of Bengal. Egypt's cultivable area is therefore only one-fifth that of Bengal. But while the national revenue of Egypt amounts to 60 crores of rupees that of Bengal is barely twelve crores. The tax-paying capacity of Bengal is therefore twenty-five times less than that of Egypt per head.

This is largely due to the fact that a large part of the revenue which would have otherwise come to the coffers of the Bengal government is now taken over by the central government. But even all that which is drained to the central government will not raise the income beyond 30 crores. But the main cause of poverty is to be ascribed to lack of any system in *crop-raising*. In Mughal times, Bengal cotton and silk* used to clothe the whole of Europe, and she used to export large quantities of sugar to foreign countries. The districts on the two sides of the Hooghly river were famous for silk and cotton cultivation. In course of the British rule, both cotton and silk have disappeared reducing West and Central Bengal to great poverty. Jute which took their place in the system of economy in Eastern and Northern Bengal is threatened with the same fate as Dr. Ghosh shows. Silk constitutes the chief article of export for Japan and the growth of that industry in Japan is entirely due to the application of scientific methods of crop-raising and marketing. Experts are still of opinion that the old silk area of Bengal is full of vast potentialities if a determined effort be made for the resuscitation of this industry. It is not generally known that Bengal does not even produce oil seeds, like mustard mainly used by her population as edible fat, and sesamum but procures these from upcountry. Thus large parts of Bengal have been reduced only to a onecrop system, and that crop is rice which brings no surplus money. We hope that in a future article Dr. Ghosh would give us information about the possibility of raising these crops and cotton in Bengal.

We know it for certain that excellent cotton used to be produced at one time in the Dacca district. Mr. John Taylor writing in 1800 stated that a tract of land about 40 miles long and 3 miles wide in the parganas of Bikrampur, Kartikpur, Kedarpur, and Rajanagar, produced some of the finest cotton then known. Cotton was also grown in the north of the district as the name of Kapasia thana clearly indicates. Mr. James Taylor has given a full account of the system of cotton cultivation in his *Topography of Dacca* (1840) which has been reproduced in Sir William Hunter's *Statistical Account of Dacca* (pp. 84 & 85), but at the present day the cotton crop has totally disappeared. A very inferior kind of cotton is, in fact, only raised in small plots by aboriginal tribes in the forests in the north of the district of Dacca and the total area under cultivation pro-

* Tavernier (1680) writes that the total export trade in silk amounted to four crores of rupees from the market of Cossimbazar.

bably does not exceed a few acres. Cotton is still found by the hillmen of Assam to be a very paying crop; so its disappearance from the district must have happened at a time when the cultivators found that owing to the import of Lancashire cotton goods, demand for cotton goods had disappeared and that they could use their time and land to better account. But, though cotton disappeared, its place in the agricultural economy of Eastern Bengal was more than filled by another fibre—Jute. This, however, is subject to even more marked fluctuations than other staples. Over-production met its usual reward, the price fell sharply, and now even the apathetic Bengal Government is making a regular propaganda to limit its production. This is quite good, but may we enquire what the Government, nay, the Agriculture Department of Bengal, is doing or has done for the growing of cotton crops in Bengal? At present there are at least three or four cotton mills in the Dacca district alone and there is a great demand for a large amount of cotton for their respective mills, but where do they get a supply of it from? Not from the soil of Bengal do they meet their demands but from C. P. and Bombay Presidency. Sometimes they even purchase Egyptian cotton to meet their requirements.

The duty of the Agriculture Department of Bengal is now to make a propaganda amongst the peasants, explaining to them the modern method of cotton cultivation and trying to culture a variety which will suit the conditions of Bengal soil and Bengal weather and, furthermore, to make it clear to them that it will be a paying crop in the near future as the number of cotton mills is growing up day by day, so that there will arise no question about the finding of a good market for their product. Will the Government of Bengal take any step in this direction?

In this connection, I beg to draw the attention of the public to another very important question, which is not only an important point but a vital one. Bengal is an agricultural country, but there is not a single agricultural college established up till now, only there recently is a proposal of establishing one in Rajshahi which the munificence of the late Kumar Basanta Kumar Roy of Dighapatia has rendered possible. But the total income from this fund is only Rs. 15,000, and we submit that this is a mere drop in the ocean. A first class agricultural college with research farms cannot be run properly unless some lacs of rupees are annually budgeted for expenditure.

The fitness of a people to live depends not only on the quality of the land at their disposal, but also on their capacity to exploit the resources of the land to the fullest advantage. Three centuries ago, small bands of Red Indians, who used to wander over the plains of North America, eked out a poor sustenance from the land, and hunger drove them to fight amongst one another over herds of cattle & small plots of maize. Now the same land supports hundred times the population living in the highest comfort and plenty, and there is not any occasion for them to fight. This is because the new race which has succeeded the Red Indians is fully equipped with the art of development of the resources of the land, and has fully utilized them. If the people of Bengal want to live a better life than they do now, they must pool their resources together, and develop the agricultural potentialities of the land to the fullest extent according to a planned system as envisaged by Dr. J. C. Ghosh.—*Editor, Sc. & Cul.*]

Introduction

The principle of economic self-sufficiency is now dominating national enterprises all the world over; and in many countries, planned systems of economy have replaced free international competition in trade. I am not going to discuss the question whether the adoption of such economic systems will benefit humanity as a whole, or whether such forms of state intervention are compatible with full political liberty. Facing facts as they are, it cannot however be denied, that any country which now intends to maintain the orthodox attitude of *laissez faire* is doomed to suffer. Suffering in any case is inevitable during all periods of transition; but it is equally true that the extent of such suffering may be considerably mitigated by conscious action.

India is even to-day mainly an agricultural country and it is only by raising the price of agricultural raw produce that prosperity can be brought back to the countryside. When we hear of the great efforts which the other great countries of the world are making to raise prices, we naturally ask the

question "if other peoples are trying to raise prices, why should not we ?" That even in India, state intervention can help in this direction is well illustrated by the example of wheat. In Australia, the price of wheat to-day is Rs. 2-2-0 per maund and if unrestricted import were permitted, the price of wheat in India will not exceed Rs. 2-8-0 per maund near the ports as against the average market price of Rs. 3-8-0. The Government of India were very anxious that the agricultural population of the wheat-growing provinces of India—specially of the Punjab and Sind—should be protected from this disastrous competition and three years ago they passed the Wheat Duty Act for the protection of Indian wheat. India needs for internal consumption about 10 million tons of wheat which is the average yield from an area of 35 million acres. Serious attempts have been made in the wheat growing tracts to limit the cultivation to this area, so that the price of wheat may not go down by over-production ; and it is gratifying to note that the internal price-level has been kept fairly steady.

Protection for Sugar

What the Wheat Duty Act has done for the peasantry of the North-West of India, the protective tariff against the import of white sugar coupled with the fixation of the minimum price of cane at 5 annas a maund has done for the peasantry of the United Provinces and Behar. The Sugar Industry Protection Act of 1932 imposed a protective duty of Rs. 7-4-0 per cwt of sugar imported into India and also "*authorized the Governor-General in Council to increase this duty to such extent as he thinks fit whenever he finds that sugar not manufactured in India is being imported into British India at such a price as is likely to render insufficient the benefits intended to be conferred upon the Indian Sugar Industry by this Act.*" The result of this protective tariff has been that the import of sugar into India has diminished from 900,000 tons valued at 11 crores of rupees in 1930-31 to 220,000 tons valued at 2 crores of rupees in 1934-35. The phenomenal drop in imports has coincided with a corresponding growth of the sugar industry in India. This industry is now chiefly located in the United Provinces and Behar where 121 sugar mills are operating out of a total of 154 mills for the whole of India. The Indian production of the white sugar has gone up from 150,000 tons in 1931-32 to 700,000 tons in 1934-35. Not only have the agriculturists of these provinces been considerably benefitted by this protective tariff, but the industry has provided employment to thousands of middle class youths, graduates in science and engineering, and sugar-technologists. Sir T. Vijayraghavacharia, the Vice-Chairman of the Imperial Council of Agricultural research estimates that nine thousand technicians and two lakhs of semi-skilled labourers are earning their living from this industry. The industry has also created a field for the remunerative investment of capital ; some well-managed factories have been known to have paid dividends of 40% for three years in succession.

Indian sugar of the first quality now sells at Calcutta at Rs 9/-per maund, while Java sugar, if permitted to enter duty free, could easily sell at Rs. 3-8-0 a maund. For the sake of the protective policy, consumer is bearing this heavy burden of artificially maintained prices. The Government of India too has suffered huge losses in revenue. Thus in 1931-32, the revenue from import duty on sugar was 8 crores of rupees. The budget estimate of revenue from import duty and excise duty on sugar for 1935-36 is 3 crores of rupees. The Government of India have never passed through more critical financial difficulties than during the period 1931-35, but even during this period, they have, under the influence of the Indian capitalists and the Zemindars of the cane-growing tracts, forgone this huge revenue. We in Bengal cannot fail to note that this sum of 5 crores of rupees is greater than what the jute export duty brings to the coffers of the Government of India. It is also melancholy to note that Bengal has not practically participated in any one of the benefits conferred on the country by the White Sugar Act, though she has borne more than her proportionate share of consumers, burden.

I have indicated how the peasantry of Northern India bar Bengal have been partially protected from the terrible blast of world depression by state

intervention. The prosperity of the Bengal peasantry can be revived in two ways—firstly by measures aimed at raising the prices of jute and rice which are the two principal crops of the province, and secondly by a system of crop-planning and industrial development which will bring to the Bengal ryot his due share of the benefits accruing to the country from the protective measures already in vogue.

Economic Depression in Bengal

In Bengal, the price of jute dominates the entire economic life of the province. During the decade 1920-30, the average annual income of the peasantry from the sale of the crop was about 44 crores of rupees. Unfortunately the actual prices realized by the cultivators in 1932-33 was Rs. 3-4-0 per maund as against Rs. 9/- in 1928-29. The result has been that the average harvest price of the crop went down from 44 crores to 15 crores of rupees in the depression period. The Minority Report of the Bengal Jute Enquiry Committee has shown that the jute crop alone accounted for about 48% of the total value of marketable crops in Bengal in the pre-depression period. "The enormous purchasing power (amounting to 44 crores of rupees in normal years) thus secured to the agriculturists of the Province provides the very sustenance of the normal economic activities of Bengal including the trade and industry of the Province and even the pursuit of learned professions. The extent and intensity of the depression which has overtaken almost all spheres of economic activities in Bengal as a consequence of the recent débâcle in the jute trade constitutes a conclusive proof of the great importance of jute to the economic life of the Province." (Economics of Jute by Sen Gupta). While jute thus dominates the economic life of the Province, the actual area under this crop in normal years is only 3 million acres which is about 12% of the total sown area of the province. A scheme of 33% restriction as proposed by the Government of Bengal therefore requires the raising of suitable alternative crops on a million acres. This is not a difficult problem for solution; but before it can be tackled, it is essential to decide whether some kind of restriction in jute cultivation is going to be a normal feature of our agricultural economy in view of the shrinkage in international trade. It is significant that during the period 1931-32 to 1933-34, the production of jute was 233 lakhs of bales, while total export and mill consumption during the same period amounted to 236 lakhs of bales. The demand and supply almost balance each other and the cultivators under normal conditions of trade should have been able to realize prices much higher than Rs. 3-8-0 per maund. This is even less than the cost of cultivation as calculated by Mr. Azizal Haque in the Jute Enquiry Committee report by an amount varying from two to eleven annas. Why should then arise such anomaly? One school of economists headed by Mr. Sarkar maintains that this 66% drop in the price of raw jute "is to be ascribed to abnormal accumulation of stocks in the hands of Indian Mills which have had since 1930-31 more than a full year's requirements at their disposal, and to the lack of holding power of cultivators and merchants due to severe depression. The problem of adjustment of supply to demand thus resolves itself into a question of curtailing the crop to such an extent that the redundant stocks will be brought down to their normal proportions and thus prevented from exercising any prejudicial influence on the price of the fibre." He therefore recommends that the surplus stock should be brought down to six months' requirement of the industry—should be wiped out by 35% restriction of jute in 1935 and 15% restriction in 1936. The Government plan of jute restriction has followed parallel lines. Government at first decided to try by intensive propaganda voluntary restriction of the area under jute by 31% in 1935 without committing themselves in any way as to their plans for future years. It reflects great credit on the Government and people of Bengal that a restriction of 33% in the area under jute was achieved this year on a voluntary basis; * but the influence of this heroic effort on the price of jute has not been as satisfactory as was anticipated.

The reason is that those who are actually engaged in the jute trade do not share the view that restrictive measures, only for a small temporary, period, are sufficient for fixing the price level of jute on a

* Many responsible people attribute this restriction to absence of rain in early summer.

satisfactory basis. A suitable permanent scheme of restriction is necessary to achieve this end. It now appears that the Government of Bengal has been persuaded to this point of view and it has been recently announced that Government proposes to continue in 1936 the measures for jute restriction which have been adopted with success during the current year.

Alternative Crops in place of Jute

Any restriction scheme of a permanent nature immediately raises the question of the possibility of growing alternative crops on lands thus released from the cultivation of jute. Such crops should preferably be marketable money crops. Propaganda in favour of restriction of jute in future years will be of little avail if the cultivators are not shown the possibilities of growing such alternative crops. A permanent 20% scheme of jute restriction requires that alternative money crops should be grown on 600,000 acres of land. A solution which requires the least effort on the part of the people of Bengal and the least deviation from routine agricultural practices is contained in the suggestion that rice may be grown on these additional 600,000 acres. About 23 million acres covering about 87% of the cropped area of the province is already under rice—this additional 600,000 acres under rice will not in any way affect prejudicially the price of this food-grain in Bengal. Support is lent to this suggestion for growing rice by the contention that the Bengal peasantry has already shown this capacity for effecting readjustment in 1931-32 when the cropped area under jute came down from 3 million to 1·6 million acres, and the surplus lands were mostly put under rice. Additional support is lent to this view by the fact that Bengal produces less rice than is required for the consumption of her own people. This deficiency amounts to about a million tons which is normally obtained by import from Burma. 600,000 acres at the rate of 21 maunds per acre will yield only about half a million tons of rice; even then the need of import will not disappear. Unfortunately however this solution which requires the least effort, is also the least valuable as a paying proposition.

Increased Rice Cultivation not necessary

Under stress of competition from Burma, Siam and Indo-China, the price of Indian grown rice has gone down very low—in 1934 it stood at 47% of the pre-depression average price. A suggestion was pressed from Madras at the recent meetings of All India Crop Planning Conference that British India excluding Burma being a rice-importing country, the internal price-level of rice should be the imposition of an import duty. Thus the rice-growers of Bengal, Madras and Bihar should enjoy the benefits of state intervention much in the same way as the wheat growers of North West India have done. The trouble is that Burma which has an exportable surplus of 3 million tons of rice is still a part of British India. Even when under the new constitution, she is separated from British India, the trade agreement to be entered into with her will prevent the imposition of a tariff on rice for many years to come. It appears therefore that the fixation of the price of rice in India at a high level irrespective of world prices is not a practical proposition. Under the circumstances the true economic interests of Bengal will be best served by a systematic attempt at improving the yield of rice per acre, so that the present cropped area under rice may produce sufficient food for the population. The Bengal Department of Agriculture is convinced that this object can be achieved by a judicious system of the cultivation of the newly bred varieties of paddy without the cultivator incurring any additional cost by way of manures or artificial irrigation. If that is so, no sensible man can help deploring the inertia which has prevented the Government and the people of the land from taking advantage of this precious knowledge.

Prospect of Sugar Industry in Bengal

In these days of rapid expansion of the sugar industry, the possibility of growing sugar cane in the surplus jute lands of Bengal, immediately suggests itself. The consumption of white sugar in Bengal does not exceed 150,000 tons. On the basis of 9% extraction, about 1.7 million tons of cane have to be crushed in modern factories for obtaining the above quantity of sugar. Assuming an yield of 17 tons per acre, 100,000 acres must be put under cane if Bengal is to be independent of her supplies of sugar from outside. This is in addition to the land now under cane which is mostly grown

for the purpose of making *gur* for internal consumption. It is however to be borne in mind that a factory can operate economically if it is assured of a regular supply of cane within 24 hours of harvesting in the fields. If there is greater delay in reaching the factory, the cane gets dried up, part of the cane sugar in the juice is converted into non-crystallizable sugar and the percentage of recovery of white sugar goes down considerably. A 400 ton factory requires about 4000 acres of land under cane. Depending on the locality and soil condition, it may be necessary to have a three years' rotation of the cane crop or even a four years' rotation. A 400 ton factory will therefore work at its best if it is located in a compact block of cane lands about 12,000 acres in area. Such compact blocks of land are not wanting in the districts of Rajshahi, Dinajpur, Rangpur, Murshidabad, Burdwan, Dacca and Mymensingh. It is no use however asking the ryot to put more lands under cane if white sugar factories are not established to absorb this additional supply. Otherwise, the price of *gur* will go down very considerably and the economic situation will grow worse by making the cultivation of cane an unprofitable proposition.

Capitalists on the other hand apprehend that the Bengal peasant will refuse to grow sugar cane in requisite quantities if the price of jute goes up considerably. This is a matter which requires careful consideration. A rough analysis can immediately be made to find out the price of jute at which cane-growing ceases to be remunerative. The cost of growing cane in Bihar has been estimated to be $2\frac{1}{2}$ annas per maund. In Bengal, a liberal estimate will be 3 annas a maund. At a selling price of 5 annas per maund and an yield of 17 tons per acre, the net profit will be about Rs. 60/-per acre. On the basis of Rs. 4/- as the cost of cultivation of jute per maund and an average yield of 11 maunds per acre, the price of jute will have to rise to Rs. 8/-per maund before the cultivation of cane becomes comparatively unremunerative. It is sometimes maintained that jute being a monopoly produce, its price may go up higher. Already however, paper bags are competing with gunny bags in certain sections of the internal carrying trade of many countries; and if the price of cotton does not go up simultaneously, bags from cotton waste will enter the field of competition. We should not forget also that cereals are now often carried in the holds of ships without any containers and are transferred into wharves by pneumatic suction. Any attempt therefore to raise the price of jute too high will be a very risky proposition. Then again, the need for a diversified crop production for the economic stability of the province should receive due consideration; and remembering also that the rise in the price of jute is contingent on the success of some kind of jute restriction scheme, the capitalist need have no fear that a factory once started in Bengal might collapse on account of inadequate supply of cane.

Doubts have often been expressed about the suitability of Burdwan, Presidency, and Dacca Divisions for the establishment of a sugar industry. When the first sugar mill was established on the banks of the Lakhya in the Dacca district, it was considered by many to be a mad venture. 35 days' trial working during the last season has completely belied the misgivings of the pessimists. Even with the ordinary Tana cane, the extraction came out as high as 9% which is the average of the well managed factories of U. P. and Bihar using the improved varieties of Coimbatore cane. The fact is that Bengal in many ways offers better opportunities for the development of sugar industry than Bihar and U. P. In the first place, if sugar production in Bengal is limited to her own requirements of 150,000 tons, the Bengal factories will enjoy the advantage of freight to the extent of 6 to 10 annas a maund in marketing sugar, which alone ought to put the industry in an unassailable position. Secondly, the average yield of cane per acre in Bengal even now is about 17 tons as against the U. P. and Bihar average of 14 tons. The yield will certainly increase very considerably when the agricultural practices have been organized to meet the demands of modern factories. In this connection, the records of Government farms or farms under Government supervision reveal a very promising situation. The average yield of cane in the tracts lying between the banks of the Hooghly and the Saraswati is 41 tons per acre. The Central Bengal districts south of the basin of the Bhagirathi and north of the

Jhalangi give an yield of 30 tons to the acre, and the tract on the two sides of the old Brahmaputra begining from Prodyotnagar to Gaffargaon, Kishoreganj and down, has given an average outturn of 32 tons. This compares favourably with the average yield of 45 tons per acre in Java. It has also been found that some of the new improved Coimbatore varieties can stand waterlogging for a long time and their sucrose content also remains quite high. The climatic conditions of lower Bengal lie midway between the equatorial climate of Java and the continental climate of Northern India with its severe drought in summer and intense cold in winter. To counteract Java competition some sort of preferential tariff will be always necessary for the Indian national sugar industry. It appears, however; that the prospects of bringing down the cost of production of Indian sugar have better chances of success in Bengal than the other parts of Northern India.

Cane as an alternative crop for jute is specially valuable in the districts of Dacca and Mymensingh. Out of a normal area of 3 million acres under jute, these two districts account for 1·1 million acres. Any scheme of jute restriction will therefore affect very considerably the agricultural economy of these districts. It has been found that cane may be grown very profitably on the long stretch of land on the left banks of the old Brahmaputra and the Lakhya from Bahadurabad down to Kaliganj. Given enterprise and business ability, a prosperous sugar industry can be established in this area which can easily meet the white sugar requirements of the whole of Eastern Bengal and Assam. A chain of such sugar factories built at a capital cost of a crore of rupees will transform the economic situation of this part of Bengal. It will provide employment to 12,000 skilled operatives, will exercise a beneficial influence of inestimable value on the prosperity of the ryots, and may easily earn for the capitalist a profit of ten per cent per annum.

It is necessary in this connection to sound a note of warning against any attempt to manufacture white sugar by the open-pan-system in small concerns requiring a capital expenditure of about Rs. 15,000/-. The possibility of making profits in such factories has been gone into very thoroughly by the Director of Agriculture in U. P. Such factories can be run at a small profit if the extraction of sugar can be maintained at 6%. But if the extraction drops down to 5% which is very often the case, the factory must be running at a loss.

Prospects of Ground Nut Industry in Bengal

The replacement of 100,000 acres of surplus jute lands by cane out of a total surplus of 600,000 acres only touches a fringe of the problem. Other alternative money crops must be found to cover the remaining 500, 000 acres. The Bengal Department of Agriculture strongly recommends the growing of ground nut over this area. 600,000 tons of ground nut oil seeds were exported from India in 1931-32 valued at 10 crores of rupees. It is now mostly grown in Madras, Central Provinces and Bombay. The total production in 1931-35 is about 3·2 million tons of which the export market is expected to consume 20%. The production of ground nut has increased even during these years of depression by about 500,000 tons. This subject was very carefully considered in the Crop Planning Conference held in Simla in June 1934 and their conclusions may be given in the language of Mr. Burt, who is the Expert Adviser to the Imperial Council of Agricultural Research :—"The internal market for ground nut in India is extremely important. The internal market for the oil is expanding, and ground nut oil is the one oil which is being used by all the new hydrogenation plants which are producing Vanaspathi Ghee to replace imports of fats and other kinds of vegetable ghee. After going into the trend of exports and the increasing demand for internal consumption we came to the conclusion that there was room for cautious expansion specially in those provinces where the ground nut area is not very large." Bengal's present production of ground nut is negligibly small and the recommendations of the Crop Planning Conference apply to her condition with special force. The method for the cultivation of ground nut is described in leaflet No. 3 of 1933, of the Bengal Department of Agriculture. It has been found that in Bengal this crop can be grown as a *kharif* crop in the highlands during the summer and the rainy seasons, and as a *rabi* crop in the lowlands

from December onwards. In some localities in Bengal, an yield as high as 36 maunds per acre has been obtained which means an income of Rs. 200/- per acre of crop even in these days of depression. The average yield in Bengal will however be at the lowest estimate 18 maunds or ·66 tons per acre. If the produce of ground nut in Bengal is increased at the rate of 60,000 tons per year until a maximum of 300,000 tons is reached in five years, the Indian market for this crop will not be seriously dislocated in view of the expanding internal consumption. This crop will require about 500,000 acres of land yielding an average income of 1·5 crores of rupees to the Bengal cultivators. As a matter of fact it will not be difficult for the experts to work out satisfactory systems of crop rotation suitable to each locality of the province based on the following crops -- cane, ground nut, jute and *aus* paddy.

A theoretical solution of the problem of crop planning is easy; the practical realization of the possibilities indicated in such solutions is however a very difficult task. The cultivation of ground nut in Bengal has not made any progress whatsoever because the valuable knowledge has not been brought to the door of the ryot and because there does not exist any marketing organization to handle the ground nut which he might produce. Normal channels of trade are automatically set up when the supply of a commodity from a particular area has become regular; but until this has happened, the pioneering marketing work should be undertaken by the Government. The Government of Bengal would have been well advised, if instead of frittering away the sum of 16 lakhs of rupees placed at their disposal for rural development on petty schemes of little permanent value, a five year plan had been adopted with this financial backing, to develop and expand the cultivation of ground nut in this province. Such a course would have brought to the Bengal peasantry at the end of this period an income which is equivalent to 30% of the present harvest price of jute. I wonder why men in authority cannot understand that good drinking water and good cattle will take care of themselves if money can be made to flow back into the countryside.

A constructive agency is required to bring any such scheme into fruition. The Chancellor of the Dacca University in a very thoughtful address recently exhorted the educated youth of the land to go back to the country in a spirit of service to the villagers. Such appeals always strike a very responsive chord in the heart of our young men; and if the people and the Government of Bengal so will it, an organization at a small cost can be easily set up which will absorb the constructive energies of a large section of our educated but unemployed youth and will carry through well planned and comprehensive schemes of crop rotation within a short time.

I have indicated above how well directed and conscious efforts at crop planning coupled with industrial development can bring back a considerable measure of prosperity to the countryside of Bengal. Nature has endowed this land in which we live, with a soil whose richness and fertility cannot be excelled. It lies with the people of the land to make an intelligent use of this precious gift. In the Biological world, standards of efficiency are judged by the readiness with which a living organism adapts itself to changing environment, and the inefficient are not permitted to survive. In the world of human affairs, the same standards prevail, however much we wish it to be otherwise. When will the Bengalees learn this lesson of life?*

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* Synopsis of a lecture delivered at the Town Hall, Mymensingh, under the auspices of Economic Association on 4.8.35.

Some Problems of Nation-building

Subhas Chandra Bose

Karlsbad.

The appearance of SCIENCE AND CULTURE is to be warmly welcomed not only by those who are interested in the abstract sciences but also by those who are concerned with nation-building in practice. Whatever might have been the views of our older "Nation-builders", we younger folks approach the task of nation-building in a thoroughly scientific spirit and we desire to be armed with all the knowledge which modern science and culture can afford us. It is not possible, however, for political workers with their unending preoccupations to glean that knowledge themselves ; it is therefore for scientists and scientific investigators to come to their rescue.

The problems in which scientific help is needed are manifold, but in this article I shall refer to only a few of the more fundamental ones.

The first problem I shall raise is a sociological one and is as follows : Is Indian civilization in the evening of its life, or is it on the threshold of a new dawn ? (I do not want a sentimental, but a scientific reply). The awakening that we now witness, is it an organic growth from within, a new creation, or is it a mere response to the impact of the West, of the same character as the reflex of a muscle under stimulus ?

The second problem is also a sociological one : What are the conditions essential for revivifying a civilization like ours that has begun to stagnate ?

There is no doubt that when the European nations began to quarrel over the possession of India, we had reached a stage of stagnation or decay. Is there any law underlying the rise and fall of civilizations which could tell us how we could give a fresh lease of life to our civilization ? Or should we throw up our hands in despair and say that once stagnation has set in, there is no future for us as a nation ?

The third problem is also a sociological one : For increasing the vitality of our nation, should we promote inter-caste or intra-caste marriages ? Are exogamic marriages more conducive to the welfare of a people or endogamic ? Till quite recently scientific men would have been inclined to say unhesitatingly that India would do well to remove artificial restrictions on marriage. But the new racial theory of the Nazis has made us all ponder over the problem once again. If the Nazi theory is scientifically wrong and if exogamic marriages are really good for the race, then I think that it is high time to give a scientific reply to the claims of the Nazi race-theorists.

The fourth problem is concerning the proper population for a country like India. The census figures for 1931 (I am relying on the *Statesman's year-book* for 1935) show that there has been an increase of about 34 millions in India's population during the previous decade. That means that a nation that lives in a state of chronic starvation is nevertheless multiplying at a rate that puts animals to shame. Is it right ? What is the maximum population which India should have, considering the food-supply and industrial potentialities ? If India has already reached that point, how should we check the further increase of population ? Should artificial birth-control be adopted as a public policy, seeing that birth-control through self-control has failed completely ?

The fifth problem I should like to raise is concerning a common script for India. At present many prominent Indians are advocating the Devanagari script for India. But will our Mohammedan brothers accept this script ? Will it help to bring Indian culture into closer contact with the outside world or hinder that object ? To me, script is primarily a matter of convenience. What is of real importance is not script but language. And from the point of view of convenience, there is much to be said in favour of the Latin script. I confess that formerly I was very strongly in favour of adopting the Devanagari script and abolishing the provincial scripts—but my visit to

Turkey last year has made me think. I now feel that the question has to be considered in a thoroughly dispassionate matter.

The sixth problem is a medical one and is concerning a uniform reformed diet for the whole of India. There is no doubt that the daily menu of the majority of the Indian people is unscientific and unhygienic—and this is specially true in provinces like Bengal and Madras. Should not steps be taken to draw up a uniform and adequate diet for the Indian people, in consideration of the law of health on one side and our circumstances on the other ?

The seventh problem concerns a uniform dress for the people of India. While I do not desire or advocate the abolition of the provincial dresses which have a charm of their own, I feel that alongside of them there should be a common dress which the Indian people should ordinarily wear both in India and abroad. It is because we have not fixed upon such a common dress for ourselves that our people generally adopt European costume when they go abroad. But this is not only unnecessary but humiliating. The whole of Europe has evolved a common dress for ordinary use, though each country retains its picturesque national costume. This is an example to us. Will our sartorial experts now take up this problem and make a recommendation after considering our average means, our weather conditions etc. ?

I have stated a few important problems. They are enough for our present purpose. I shall now ask our scientists to take up these problems one by one and give a satisfactory answer. Without the co-operation of science, no nation-building is possible.

Sounding the Depths of Space

When we peer into the abysmal depths of space through an instrument like the 100 inch telescope (Fig. 1), we find innumerable stars, star clusters and spiral nebulae, apparently without end and our mind staggers at the immensity of the universe thus revealed. One of the marvellous achievements of modern astronomy is the accurate measurement of the distances of these heavenly bodies which are unimaginably remote from us. As a direct outcome of this, we are now in a position to gauge the size of the visible universe.

FIG. 1. The 100—inch Hooker Telescope.

During the eighteenth century it was realized that the sun and the stars were similar bodies. It was also realized that the stars, though at very great distances, were yet finite. Edmund Halley, the Astronomer Royal, found that the positions of the three bright stars, Sirius, Arcturus, and Aldebaran, were slightly different from those in Ptolemy's catalogue, though the positions of other fainter stars agreed with those in the catalogue. Hence, he concluded that this might be due to the movement of the stars themselves relative to the solar system during the 2000 years. This discovery gave the astronomers some hope of determining the distances of the stars with more refined instruments and measures.

The distances of the sun, moon, and other nearer bodies can be found by observing the difference in their directions from two points on the earth's surface. This method will not be of any use for measuring stellar distances, as the stars are at very great distances from us. It was discovered that the earth's orbit round the sun could be used as a suitable base line for this purpose. In the course of six months, the earth moves from a point 93 million miles on one side of the sun to the same distance on the other side. So, when the nearer stars are viewed first from one end of the earth's orbit and six months later from the other end, it is seen that certain stars change their position slightly, relative to the rest of the stars. These stars which are nearer appear to move against the background of more distant stars when our position of observation is changed by 186 million miles. This change of position is equal to the angle subtended at the star by the earth's orbit (Fig. 2). Half of this angle is

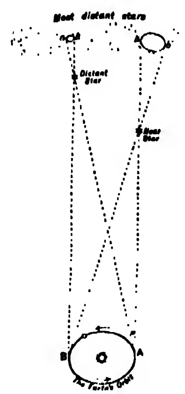
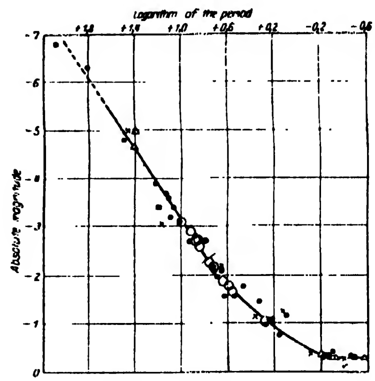


FIG. 2. Stellar parallactic ellipses due to the earth's revolution round the sun. The nearer a star is, the large is its apparent parallactic ellipse. Half the angle shown at a star is its annual parallax.

known as the parallax of the star. The work of determining the parallax of a star is extremely delicate and very laborious, and as the angle is extremely small even for the nearest stars the utmost care is necessary to avoid instrumental errors. The determination of the star's distance, from the parallax is simple geometry, as the radius of the earth's orbit is already known.

The contemporaries and successors of Copernicus could not find the slightest trace of any such parallactic effect. But success dawned with the appearance of better and improved means of measuring angular positions. Bessel, Henderson and Struve were the first to determine successfully the parallaxes respectively of 61 Cygni, α Centauri and Vega. The nearest star to the solar system is Proxima Centauri which is nearly 4.2 light-years away. By a light-year we mean the distance covered by light in one year travelling at the rate



SHAPLEY'S Period-Luminosity Curve

FIG. 3.

of 186,000 miles per second. The velocity of light is the astronomical yard-stick with which we sound the depths of space. If we start in an aeroplane and continuously travel at 100 miles per hour, it will take 30 million years for us to reach Proxima Centauri! The whole drama of life on this earth be over within this period

Another and much easier method of determining stellar parallaxes is the spectroscopic. If a pair of spectrum lines is selected, one of which is strong in giant stars and the other in dwarf stars and their relative strength determined in the spectra of a number of stars of the same class and of known absolute magnitude or real brightness, and if these estimates are plotted against the respective absolute magnitudes, a smooth curve is obtained. From this standard curve the real brightness corresponding to any given relative strength of the lines can be found.

Now $5 \log_{10} p = M - m - 5$, where M is the absolute magnitude or real brightness, m the apparent magnitude or brightness which is always known with sufficient accuracy, and p the parallax. From

this we can determine the parallax of the star. There is generally a good agreement between the parallaxes thus determined and by the trigonometric method.

There are several huge star clusters and spiral nebulae very much farther away in space. Certain stars are found in these which show a regular periodic variation in their brightness and are known as variable stars. Those stars with short periods

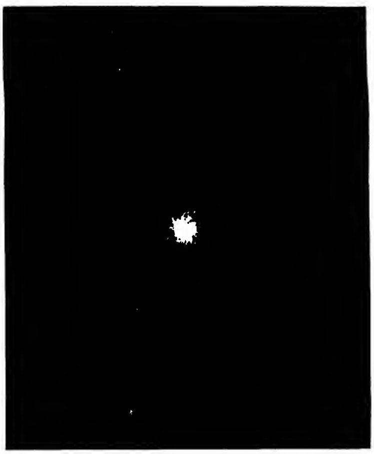


Fig. 4. The Star Cluster M. 3 canum Venaticorum.

are known as Cepheid variables, after the typical star δ Cephei. Miss Leavitt of Harvard discovered a close correlation between the median photographic magnitudes and the periods in Cepheids. From this a curve has been constructed by Prof. Shapley connecting the period and the absolute magnitude or real brightness of these stars, called the 'Period-Luminosity Curve' (Fig. 3). From this standard curve the absolute magnitude of any Cepheid whose period is known can be found.

Now $\log p = -1 - 1{\cdot}5\ (m\text{-}M)$ where the symbols have the same meaning as in the previous equation. From this the parallax p can be easily found and hence the distance. The distance thus determined for the globular cluster M. 3 (Fig. 4) comes out to be 15,000 light-years and, that for the

Fig. 5. Great Nebula in Andromeda.

Andromeda Nebula (Fig. 5), which is one of the nearest spirals and an 'island universe' in itself, 870,000 light-years! We have to really marvel at the human intellect for its such wonderful achievements in recent years.

—*Antares.*

Life and Work of Sir Lewis Fermor

Sir L. L. Fermor was born in London on the 18th September, 1880 and entered the Royal College of Science with a National Scholarship in Physics and Chemistry, also obtaining the second place in the Honours list of the London Matriculation. Winning the Murchison medal in Geology, he graduated A. R. S. M. in Metallurgy in 1901. Thereafter he continued his studies in geology and was appointed Assistant Superintendent in the Geological Survey of India in October 1902. In 1906 he took the B.Sc. (Lond.) by research and the D. Sc. in 1909. Two years after joining the Geological Survey he was promoted to the grade of Deputy Superintendent, and to Superintendentship after eight years' service and has been both Curator and Palaeontologist of the Geological Survey of India. In 1922, 1925, 1928 and 1930 to 1932 he officiated as Director, being confirmed in the latter year. During 1917 and 1918 he was transferred to the Munitions Board, and was awarded the O. B. E. for his work in the War.

During his first few years in India Sir Lewis was occupied chiefly in the examination of the manganese deposits of India and the rocks in which they occur, field-work which resulted in his monumental four-volume memoir on the 'Manganese-Ore Deposits of India (*Mem. Geol. Surv. Ind.*, *37*, 1909). Not only is this an exhaustive treatise on the occurrence of manganese in nature, the manganese-containing minerals, the manganese-ore deposits of India, their geological considerations and the methods of working, but it contains a critical discussion of the Archaean rocks of India, which is still the last word on the subject. It is expected that the freedom from routine duties which retirement brings will enable Sir Lewis to amplify this section and enrich it with a quarter of a century of further experience into a series of memoirs the first of which is almost ready for the press.

On his manganese investigations followed examinations of the Singhbhum and Sikkim copper deposits, the iron-ores of Ratnagiri and Goa, the hill-slopes of Darjeeling with reference to landslips, the Bokaro and Korea coalfields, the chromite of Baluchistan and Singhbhum and mica in Ajmer and Orissa.

In conjunction with these economic enquiries, the results of which are in part embodied in two papers on the 'Mineral Resources of the Central Provinces' (*Rec. Geol. Surv. Ind.*, *50*, 1919) and the 'Mineral Resources of Bihar and Orissa' (*Rec. Geol. Surv. Ind*, *53*, 1921), Sir Lewis continued the survey of the Central Provinces and Bihar and Orissa by personal field-work and by the superintendence of field-parties until he succeeded to the Directorship.

In addition to the three comprehensive publications cited and other major papers on 'The Petrology and Manganese ore Deposits of the Sausar Tahsil, Chhindwara District, Central Provinces' (*Rec. Geol. Surv. Ind.*, *33*, 1906), 'The Deccan Trap Flows of Linga, Chhindwara District, Central Provinces' (with Dr. C. S. Fox, *Rec. Geol. Surv. Ind. 47*, 1916) 'The Basaltic Lavas penetrated by the Deep Boring for Coal at Bhusawal, Bombay Presidency' (*Rec. Geol. Surv. Ind.*, *57*, 1925) and 'The Geology and Coal Resources of Korea State, Central Provinces' (*Mem. Geol. Surv. Ind.*, *41*, Pt. 2,1914) he has published some forty papers on manganeses-ore and other ore deposits, on new manganese minerals, on the Archaeans of India, on the eclogitic snell of the earth and problems connected with garnet, on the sinking of olivine and labradorite in molten basalt, on meteorites, on structural problems, on the colloid nature of coal and the density-ash relationships and on geological nomenclature. He has also collaborated with Sir Thomas Holland and Sir Henry Hayden in the Quinquennial Review of the mineral production of India for the periods 1904-1908 and 1909-1913, and contributed the articles on manganese in the succeeding Quinquennial Review for the periods 1914-18, 1919-1923, and 1924-1928. As Director, Sir Lewis compiled the Annual Reviews of the Mineral

Production of India for the years 1921, 1924, 1927, 1929, 1930, 1932 and 1933 and the General Reports of the Geological Survey of India for 1921, 1930, 1931, 1932, 1933 and 1934.

As representative of the Government of India Sir Lewis attended the International Geological Congresses in Sweden (1910), Canada (1913), Spain (1926) and South Africa (1929), and is editor for the volume on Asia of the International Lexicon of Stratigraphy in preparation by the Congress. Since 1923 he has acted as Assistant Editor, *Economic Geology* and in 1932 was Vice-President, Society of Economic Geologists.

During his periods as Director, Sir Lewis was President of the Governing Body of the Indian School of Mines, Trustees of the Indian Museum, and Honorary Treasurer and Editor of the *Transactions*, Mining and Geological Institute of India; in 1906 he was awarded the Government of India Prize and in 1917 the Silver Medal of the Institute. Since 1930 he has been a Member of the Governing Body of the Government School of Art, Calcutta.

In scientific societies in India, Sir Lewis has been Vice-President of the Asiatic Society of Bengal for six years and is now its President, as well as President of the National Institute of Sciences of India the successful launching of which is in no small measure due to his tact and perseverance. In 1919, he was President of the Geological Section of the Indian Science Congress, and in 1932-33, President of the whole Congress. Sir Lewis was also a Founder Member of the Himalayan Club and was Vice-President in 1931 and 1932.

Sir Lewis Leigh Fermor.

Outside India Sir Lewis is a Fellow of the Geological Society of London, the Bigsby Medal of which he was awarded in 1921, a member of the Mineralogical Society and of the Institute of Mining and Metallurgy and a Fellow of the Royal Society.

Anthropometric Study of the Growth of Skulls

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Anthropology Department, Calcutta University.

The old Hindu concepts of harmonic proportions in a study of the most longlived man as we find in Susruta is likely to prove of immense value even at the present day. Nagnajit, another ancient master of India who lived possibly very near Afghanistan prior to the Christian era, has introduced definite canons of bio-harmonic proportions in man which was current from India to China in the middle ages.

Susruta has introduced us to the idea of harmonic relations in the frontal, parietal, and occipital regions of the human head. Nagnajit laid down that in the facial region of the perfectly shaped leader of men, the frontal, nasal and the lower facial portions are identical in proportion.

The number of measurements taken today on the human body is legion. In these studies often the essentials are side-tracked in a search for chimerical theories. They might lead to the establishment of fanciful biotypes but do not serve the purpose of making us comprehend fully the trend of bio-harmonic growth in man. A proper understanding of these tendencies and processes is likely to be of the greatest service to man leading to the proper measures in the attempts of betterment of racial constitution and safeguarding racial hygiene.

The Hindu anatomists well divided the human body into 'sâkhâ' (branch regions) 'kânda' (trunk) and 'uttamânga' (the best part, head). Needless to state that in the study of the evolution of man the last part, the brain-box, is of the greatest importance.

Western palaeontological investigations have now laid before us a long series of evolving fossil skull types. Thus from Gregory or Broom we get a series of early fish, amphibia, reptile and primate skulls which they are disposed to consider in an ascending evolutionary order. The external contours of the skulls of this phylogenetic series may be profitably studied Cartesian coordinates and geometrical analysis.

The master-biometrician of today has been trying to perfect methods of coordinatographic study of human skulls. Those can be carried on further by the applications of principles of analytical and differential geometry. (Karl Pearson: The Cranial Coordinatograph. The standard planes of the skull and the value of Cartesian Geometry to the craniologist with some illustrations of the new method, *Biometrica*, *75*, 217-53, 1933).

In the geometrical study of curves by Cartesian Co-ordinates the determination of three reference planes perpendicular to each other is needed first of all. Then the coordinates of any point on the curve with reference to these planes are sought.

Karl Pearson in his coordinatographic studies has tried to find out after much trial three such standard planes of reference. The Frankfurt Horizontal plane which had been hitherto accepted with regard to the other two perpendicular planes as the standard was not found to be adequate for the purpose. He has taken the First Standard Plane as the plane of maximum symmetry, the Second Standard Plane as the horizontal plane, and the Third Standard Plane as the transverse vertical plane.

The mid-sagittal plane is drawn in five different ways :—

(1) the plane of maximum symmetry as the standard mid-sagittal plane ;

(2) plane perpendicular to the auricular axis at mean elevation of mid-sagittal points ;

(3) plane perpendicular to auricular axis through mid-porion :

(4) usual mid-sagittal plane or plane through Nasion, Bregma and Lambda as is generally taken in Biometric laboratory ;

(5) plane through Nasion, Inion and Basion. This is Martin's mid-sagittal plane.

Frassetto with his unsurpassable insight in the study of the morphology of human crania thus points out, "The comparison of fossil crania with modern skulls shows the enormous progress both morphological and functional that has been made in the encephalic extremity of our body. Ontogenesis in its turn shows us the important part played by the head, the head which since the first part of its intra-uterine life as well as after birth up to the first or second childhood strikes us by its great development, the infant being nothing but a cranium and a trunk...In the course of the development of the individual the human skull is subjected to numerous modifications. The three principal modifications are of structure, size, and form which are mutually interdependent or independent. Not only the form of the skull as a whole is to be taken into consideration, but also the bones, frontal, parietal and occipital, which during the three principal individual stages of development, foetal, infantile, and adult, combine to give it its particular shape. During the foetal stage the skull viewed from above is of a pentagonoid contour more or less straight or large in size, in the infantile stage the skull approximates more to an ovoid type and in the adult phase it resembles a spheroid or an ellipsoid. (In the differentiation of the forms of the foetal, infantile, and adult types, the parietal plays the most important part (Fabio Frassetto : Les Formes nomales du Crane humain, leur genese et leur classification, *Bull. de la Soc. de Morph.* p. 7, 38 & 44, 1929). When these bones of the cranian vault have a harmonic development they thus result in several harmonic forms of skulls in the two main biotypes, the Eurafrican and the Eurasiatic (*Ibid* p. 39).

In studying the phylogenetic evolution of man the importance of these cranial bones is well realized. Comparing the primate groups and men we find that the growth and perfectioning of binocular vision through earlier phases of conjugate vision and co-ordinate movement of the eyes has been manifest in the bulging out and fullness of the occipital and frontal bones, and the similar development of the parietal bones has gone hand in hand with the development of the auditory senses, music, phonation, and vocal speech. It is the visual and the auditory areas in the brain that have been in the vanguard of progress in the primate evolution and this has left its impress in the fronto-occipital and parietal regions. In his excellent survey of the evolution of the human head Piveteau, talking of the evolution of the sense organs, says, "The centre of coordination of the movement of the eyes is found in the pre-frontal region. It is not found in the Macroscelides and slightly developed amongst the Tupaia ; it is found much more developed in Tarsius and the monkeys, and its maximum expansion is to be found in man... Each retina is projected in some way on the occipital lobe of the other cerebral hemisphere—this also determines a visual field. If we consider a series of insectivores and primates in features which lead to man we find that this visual field is at the beginning very much restricted, but is expanding, gradually culminating in the occupation of a great part of the cerebral cortex, very slight in the Macroscelides but much more developed in the arboreal insectivore Tupaia, having a much more extended area in Tarsius, still more extended in the monkeys and attaining its greatest development in man...So also as the visual function has played an essential part in human evolution, the auditive function is of the greatest importance in his social life. It is only amongst the animals with well developed auditive organ that speech could appear and in a certain sense the history of audition is mixed up with that of phonation". (Piveteau—L' histoire de la tete humaine—*L' Anthropologie 44*, p. 113-5, 1934).

So in the skull series the nature of the curve or the trend of growth of the frontal and occipital as also of the parietal bones may be mathematically studied. It does not matter if the curves be known or unknown or only some portion of the curves be known, irrespective of the nature of the skull.

The fundamental aspect of the growth of these curves moulds the structure of these skulls. They are then parts of the solid figure of the skulls. The cranioscopic technique is very helpful in the study of the possible modes of variation of the skull. Martin has well remarked, "A series of traits in the

structure of the skull which is not very little ascertainable through craniometeric method can be known with more or less precision by the simple method of cranioscopy whereby other characteristics are also brought out." (Martin, *Lehrbuch der Anthropologie*, 2 p. 687). The 16 primary forms or varieties which Sergi determined in 1893 were later on, following new and accurate observations, reduced to 9 as follows :—(1) Ellipsoid—a cranium in which the norma verticalis presents an elliptical contour and it may be inscribed in a parallelogram, it has much regularity and maximum breadth in the middle, the parietal bosses are feebly impressed and the occiput is rounded ; (2) Pentagonoid—the skull may be inscribed in a pentagon, the sides are unequal but symmetrical, contour rounded, occiput protuberant, parietal bosses distinct; (3) Rhomboid—which has a small frontal region relative to the broad parietal and a distinct vertical height ; (4) Ovoid—with a flattened frontal and occipital regions and widened parietals ; (5) Beloid ; (6) Cuboid ; (7) Sphenoid with a wide parietal narrowing to a frontal in the shape of a wedge ; (8) Spheroid—the curve in each part of the cranium, that of the frontal, parietal, parieto-occipital and basal part of the occipital also has a tendency to assume a spherical shape though a perfect spheroid is not easy to find ; and (9) Platycephalus—referring exclusively to the vaultage of the skull. These 9 prinicipal varieties were later on reduced to 5, the Pentagonoid, Ovoid and Ellipsoid represnting the three principal varieties of the Eurafrican group, and the Sphenoid and the Spheroid representing the two principal forms of the Eurasiatic group. (Frassetto, *Lezioni di Anthropologia* 2 part 1 p. 294-7, 303). Frassetto has proposed a new classification subdivided into three each. His classification is extremely valuable from the standpoint of growth of the three bones, frontal, parietal and occipital . . ."If the three bones have the foetal conformation the result will be two pentagonoid forms, one relatively straight (stenopentagonoid) of Eurafrican type and one relatively large (eurypentagonoid) of Eurasiatic type. If the three bones have an adult conformation it will result for the first into an Ovoid and for the second into a Sphenoid. If finally these three bones have the adult conformation it results in an ellipsoid for the Eurafrican type and a Spheroid for the Eurasiatic type." (Frassetto, Les Formes normales etc. p. 36). Martin has criticized the cranioscopic method for ignoring the biological points in the skull and laying almost the sole emphasis on the norma verticalis. It is also possible that its overemphasis on the two biotypes, Eurafrican and Eurasiatic, may be called into question. On the other hand its clear enunciation and appreciation of the factors predominant in ontogenetic evolution and its concept of harmonic forms resulting from the harmonic growth of the three cranial portions covering the respective bones most concerned in human evolution shows its strongest biological value. We also clearly realize the tendency of the modern human skulls to assume a more or less ellipsoid or ellipso-spheroid forms starting from a foetal smaller or larger pentagonoid shapes. In the march of human biotypes from the prehistoric times to the present day one discerns the longitudinal and vertical expansions and disharmonic contours in the fronto-occipital and the parietal regions leading to the establishment of comparatively stabler bioharmonic types.

The change in the formation of types of skulls from primates to man, whatever may be the line of descent of them, is the vital point, the march of which in the line is a right impetus to all growing mathematicians to expound principles, hypotheses and equations to work with. In the case of biological development in the line of descent of human biotypes the mutual correlations of the separate bones of the same skull bear some relations with the corresponding mutual correlations of the bones of the skull of the next in descent amongst the biotypes. The line of descent of the biotypes traced out by change-point in the formation of types of different grades of skulls might well hit upon some mathematical line or curve. The analytical study of the line or curve might as well explain what would be the final bioharmonical type of the series in the descent.

The study of the contours of the skull, the separate study of each bone of the skull and the skull itself and the study of the nature of the surface or surfaces that each bone and the skull itself represents, as well as of the solid figure or figures from the above nature of the surface or surfaces and of the skull, is a good subject matter of analytical

geometry and of differential geometry. The study might give some clue to the right descent of the biotypes. The mathematical representations of the change in the surface nature of the fronto-parietal and occipital bones of the fossil and modern skulls and the biological functions that correspond to the line of descent of the biotypes from the mathematical relationships thus arrived at form the object of mathematical investigation in the subject. So in the skull series the nature of the line of growth or the trend of growth of the frontal, parietal and occipital bones is to be studied. The equation or equations of trilinear coordinates thus obtained would show the nature and line of descent of the biotypes.

The equations to three planes of reference by the help of coordinate geometry might be put well. The intercepts made by each of the planes on the three axes are to be stated clearly. The line joining any two points on the skull or on any one of the three bones of the skull might thus well be attained.

The equation involving any or more of the coordinates of the variable change-point or the locus of it represents a surface, or a system of surfaces, that corresponds, or correspond, to a definite bone or bones of the skull.

The use of the parametric system (curvilinear coordinates) originated with by is a right operation of the geometrical analysis of the above surface or the surfaces.

The Cartesian form of any surface is given as $F(x, y, z) = 0$ where x, y and z are the co-ordinats of any point of the surface.

The change in the function of vision and change of the surface of frontal and occipital lobes may be due to their being some function of parameters p and q.

Then after an appropriate adjustment of curvilinear coordinates whose arc-element (originally studied by Lioville) may be amenable to the symbolic form $ds^2 = (p-q)\ (r^2\, dp^2 + s^2\, dq^2)$ where p and q are exclusive functions of p and q, s those of q.

Or it might be some other form or forms as the case may be.

Obituary

Lt-Col. H. W. Acton

The medical world has been poorer by the loss of Lt-Col. H. W. Acton whose death was recently announced. He entered the Indian Medical Service in 1907, being placed first in the competitive Entrance Examination. In 1910 he was posted to the Pasteur Institute of India at Kasauli as Assistant Director. Here as a result of two years combined investigations, he and Col. Harvey, the then Director of the Institute, found out a safe, efficient and reliable carbolized vaccine for antirabic treatment, the present day safety and efficacy of which is in no small measure due to the work of these two officers. In 1912 when Col. Harvey was transferred to the Central Research Institute, Kasauli, as its Director, Lt-Col. Acton became Director of the Pasteur Institute and during the next three years he, together with Col. Knowles, made an intensive study on snake bite. These investigations led to the publication of a large memoir on the subject which forms even to-day one of the outstanding contributions to our knowledge of it. In 1918 on his return to India from Mesopotamia where he had gone on military service in 1916, he was posted to the malarial convalescent depot at Dagshai. Here, Col. Acton and his colleagues carried out valuable research work showing that the other alkaloids in Cinchona bark were as effective as quinine in the treatment of malaria. In February, 1921 he joined the Calcutta School of Tropical Medicine as Professor of Pathology, Bacteriology and Helminthology, and became also its Director in July, 1928. The work he carried on here on epidemic dropsy still constitutes a very important contribution to the study of that disease. He also made a special study of tropical skin diseases for which he gathered together a wealth of material. In recognition of his valuable services he received the award of the C. I. E. in January, 1931. Col. Acton unfortunately became seriously ill in 1933 and went to England on leave. He was a source of inspiration and encouragement to his students and colleagues, and lent lustre and brilliance to his profession. By his death the medical world in general and the Indian Medical Science in particular have lost a valuable worker.

Dr. Bruehl

Dr. Brühl whose death was recently announced was connected with the Calcutta University in various capacities for more than 28 years. He came to Calcutta from Rajshahi where he had served as the Professor of Botany in the Government College, and was the Professor of Physics in the Civil Engineering College, Sibpore. He also acted for sometime as the Principal of that College. Dr. Brühl was a Fellow of the Calcutta University from 1904 to 1926 and was a member of the Faculties of Science and Engineering and sometime Dean of the Faculty of Engineering and President of the Board of Studies in Engineering. He served as the Registrar of the Calcutta University from 1913 to 1917. The author of a number of papers on Botany and Physics, Dr. Brühl was appointed in 1918, the Professor of Botany of the Calcutta University, which post he held till his retirement in 1928.

Mr. H. Cooper

We are very sorry to learn the untimely death of Mr. H. Cooper, Works Manager and Director of Messrs. Smith Stanistreet and Co. Ltd., manufacturing and wholesale chemists of Calcutta. Prior to his arrival in India, Mr. Cooper was the Research Chemist of Messrs. Burrowghs, Wellcome & Co. London, and since coming to India in 1919 he had been closely associated with the principal activities of the chemical and pharmaceutical trade of the country. He was the Vice-President of the Institution of Chemists (India) and the President of the Bengal Pharmaceutical Association at the time of his death.

Notes and News

Grants for Agricultural Research.

More than Rs. 13,00,000 have been sanctioned to be spent during the next five years at various centres in India by the Governing Body of the Imperial Council of Agricultural Research for research work.

Among the commodities to benefit are sugar, oil-seeds, wheat and dairy products. The industries favoured are poultry and goat and sheep breeding.

The schemes sanctioned are :—

A scheme of investigations on the various diseases of plants in the Bombay Presidency at a cost of Rs. 80,474.

A proposal for the continuance of the statistical section of the Imperial Council for five years from December 1, 1935.

A scheme of work on insect pests of sugarcane put up by the Director, Imperial Institute of Agricultural Research for a grant of Rs. 1,49,366 spread over a period of five years.

Proposal for continuation of the Karnal Sugarcane sub-station.

A scheme from the Government of the United Provinces for a grant of Rs. 9,924 spread over five years for the continuance of the study of sugarcane seedlings at Sahajahanpur.

A scheme from the Government of Bengal for a grant of Rs. 11,800 spread over five years for the continuance of the Sugarcane testing station at Dacca.

A scheme of the Government of Baroda for a grant of Rs. 20,000 spread over five years for an investigation of suitable types of canes for Gujerat.

A proposal for a Bureau of sugar standards under the Sugar Technologist. (It was said that the work might be done at Cawnpore at the Harcourt Butler Technological Institute until the Sugar Technologist takes it over when the new central sugar research institute was started at Cawnpore.

A scheme of the Government of Bombay for a grant of Rs. 1,22,310 spread over a period of ten years for research in goat breeding in the Bombay Presidency.

A scheme of Mr. J. J. de Valois of the Agricultural Institute, Katpadi, for research on goat breeding at a cost not exceeding Rs. 84,172 (Rs. 5,480 non-recurring and Rs. 78,692 recurring) spread over a period of ten years.

A scheme of the Government of the Punjab for a grant of Rs. 42,820 spread over a period of ten years for investigation of indigenous sheep breeding.

A scheme of the Government of the Central Provinces for a grant of Rs. 61,400 spread over a period of five years for research on oilseeds in the Central Provinces. A grant of Rs. 52,280 only was sanctioned.

A scheme from the Government of Bengal for a grant of Rs. 63,680 spread over a period of five years for research on the linseed crop by the Department of Agriculture, Bengal. A grant of Rs. 20,880 only was sanctioned.

A scheme of Agricultural Institute associated with the Allahabad University, Allahabad, for grant of Rs. 37,847 spread over five years for a detailed study by Dr. Burch H. Schneider of the nutritive values of the proteins of the principal nitrogenous food crops grown and consumed in India.

A scheme of the Government of Bihar and Orissa on the feeding of minerals to cattle in Bihar and Orissa at a cost of Rs. 73,540 spread over a period of five years.

A scheme from the Government of the United Provinces for a grant of Rs. 1,36,700 spread over five years for a scheme of practical research into the feeding of cattle at the departmental farms.

A scheme for a central tobacco research sub-station at Guntur in the Madras Presidency.

A scheme from the Government of the Punjab for a grant of Rs. 25,860 spread over a period of five years for research in the improvement of poultry for table purposes in Northern India.

It was explained by Mr. Ware (Officiating Animal Husbandry Expert) that the proposed central poultry institute would deal with the fundamental problems of disease, nutrition and genetics, and also carry out industrial research, but that other work would be left to the provinces.

A scheme from the Punjab Government for a grant of Rs. 6,200 for the year 1936-37 for the continuance of the locust research scheme for the study of the biology and bionomics of the locust conducted at Lyallpur.

A scheme from the Government of the Central Provinces for a grant of Rs. 35,500 spread over a period of five years for research work on pan cultivation.

A scheme from the Government of the Punjab for a grant of Rs. 2,000 towards the cost of training of an assistant of the Agriculture Department, Punjab, in agriculture in America and other countries.

A scheme from the Government of Bengal for a grant of Rs. 5,000 spread over a period of five years for a scheme for investigation into the method of extraction of flax fibre.

A scheme from the Government of Bombay for a grant of Rs. 6,000 spread over three years for a scheme of investigations of problems of sunn hemp cultivation. A grant of Rs. 3,360 only was sanctioned.

Grants for Rural Development

Sir James Grigg, Finance Member, laid on the table of the Legislative Assembly recently, in reply to a question by Mr. B. K. Das, a statement showing how the Government of India grant for rural development in 1935-36 was to be spent.

The statement recalls that the money was to be spent on schemes approved by the Government of India which would improve the economic position and was meant to cover measures designed to improve the actual monetary income of the people as well as those designed to improve their health and education. The schemes were of course to be over and above the ordinary activities of the Provincial Governments.

Rs. 92½ lakhs had been allotted (as follows) and Rs. 5½ lakhs had been kept in reserve :—

Madras Rs. 14 lakhs; Bombay Rs. 7 lakhs; Bengal Rs. 16 lakhs; the U. P. Rs. 15 lakhs; the Punjab Rs. 8.5 lakhs; Burma Rs. 5 lakhs; Bihar and Orissa Rs. 12.5 lakhs; the C. P. Rs. 5 lakhs; the N.-W. F. P. Rs. 3 lakhs; Assam Rs. 5 lakhs; and Delhi, Ajmer-Merwara and Coorg Rs. ½ lakh each.

Immediately the demand was passed by the Legislative Assembly, the local Governments were asked to submit schemes.

The scope for initiative and experiment in rural reconstruction was of course vast, but the Government of India had decided to give the lead to the Local Government by indicating certain categories which, in their view covered most of the pressing needs of village life and offered the most practical benefit. These categories are as follows :—

1. Sanitary measures, *e.g.* (a) anti-malarial schemes, (b) village water supply, including well boring and (c) village sanitation, including drainage;
2. Consolidation of holdings;
3. Village roads;
4. Discretionary grants to District Officers in order to enable them to promote or assist minor local works of improvement.

The Local Governments were told that the Government of India would accept without question schemes falling under these heads.

Details for the spending of the Rs. 16 lakhs grant to Bengal are as follows :—

The establishment of seed, paddy and crop demonstration centres Rs. 1,09,000; for improvement of cattle and fodder crops Rs. 1,75,000; for the improvement of poultry Rs. 500; for propaganda in districts through loud speakers and gramaphones Rs. 20,000; for wireless transmission in Midnapore district Rs. 82,000; improved marketing of jute and paddy Rs. 5,000; coir spinning and weaving Rs. 40,700; Union Board dispensaries and improvement of water supply Rs. 3,50,000; attachment of agricultural farms, etc. to secondary schools and the provision of playgrounds and village halls Rs. 1,800; Boy Scouts, Girl Guides and *bratachari* Rs. 20,000; minor drainage and flushing schemes Rs. 3,30,000; Chittagong Hill Tracts Rs. 25,000; discretionary grants to Commissioners and District Officers Rs. 2,17,000;—total Rs. 16 lakhs.

Flood Relief Measures

A statement on the recent floods in the Burdwan division and the relief measures undertaken by the Government and various non-official bodies was made by the Hon. Sir B. L. Mitter in the Bengal Legislative Council. After giving a description of how the flood arrived, and mentioning the various parts of the country which suffered most, he gave an account of the organization of relief work both official and non-official.

"On August 17 the Hon. Member-in-charge of the Local Self-Government Department, visited Burdwan and attended a conference of leading officials and non-officials at the Burdwan Raj Palace presided over by the Maharajadhiraja Bahadur.

"A strong relief committee was formed and the Revenue Chamber assured the conference that the Government would do all that was possible to relieve distress caused by the flood. Several non-official agencies were already at work and the Collector and the District Board had already been distributing gratuitous relief.

It was decided at the conference that all relief measures should be co-ordinated to avoid overlapping and consequent waste.

"The extent of the damage is not fully known yet, but in the flooded area a large number of *kutcha* houses have collapsed. The only ascertained loss of life due to the flood is the case of a girl in the Galsi circle who was killed by the collapse of a house. Several deaths from cholera have subsequently been reported but details are lacking. About 200 heads of cattle are reported to have been drowned but the number may be larger.

"The area mainly affected north of the Domodar lies in the Galsi and Burdwan circles, and here two non-official organizations have been distributing relief from the very outset. South of the river, where transport is difficult, seven official relief centres have already been opened, and a few non-official relief parties are also at work.

"The Commissioner has already posted to Burdwan four additional officers on relief work and three more officers have been deputed by the Government. Three Settlement Kanungos, with experience of flood relief work, have also been deputed.

"The District Board has decided to take adequate measures for relief. The Government have already placed at the disposal of the Collector a sum of Rs. 45,000|- for gratuitous relief. Instructions have been issued that out of this amount Rs. 5,000|- should be distributed to assist the people in rebuilding their houses.

"The Commissioner has visited Burdwan several times and is in close touch with the situation and the Collector and other officers are touring the affected areas. Every effort is being made to re-transplant the areas with paddy where the crop has been damaged by flood by obtaining seedlings from elsewhere.

"Five doctors and six sanitary inspectors have been sent out with 24 pounds of cholera mixture, 16,000 influenza tablets, 30 pounds of quinine tablets, 60 hundred-weights of bleaching powder and 16,000 doses of anti-cholera vaccine. The District Board is also distributing medical relief in the affected areas."

Floods in Bihar

Making a statement in the Bihar and Orissa Legislative Council on the agricultural situation in the province arising out of the lateness of the monsoon and the floods in August, the Hon. Mr. J. A. Hubback said :—The most serious floods occurred in the Gaya and the Patna districts. The Punpun, with its tributaries, the Morhar and the Dardha, came up in flood during the second week of August.

The greatest damage to crops was in and around the Jehanabad subdivision of the Gaya district, where the *bhadai* crop was very seriously damaged. Damage is also reported in the southern *thanas* of the Sadar subdivision of Patna and in an area round Fatwa in the Barh sub-division. In the Bihar subdivision too some damage to *bhadai* crop has been caused by the flood.

Another effect of this flood was to suspend railway traffic on the Grand Chord line for about two days owing to fears for the safety of two bridges in the neighbourhood of Palmerganj. Traffic was for the time diverted through Patna. A bridge at Akbarpur at the southern extremity of the Dehri-Rohtas Light Railway was carried away by timber floating down the stream it crosses. Considerable damage has been done to communications in the eastern part of Patna district. The Fatwa-Islampur Light Rail-

way has lost a bridge while the Bihar-Bakhtiarpur road has been breached in several places and the new Ranchi Road cut a little south of Bihar Shariff and again between Nawadah and Rajauli and between Rajauli and Dabaur. The District Board road between Bakhtiarpur and Patna City also suffered some damage.

An alarming feature of the flood was a threat to Patna City itself. An iron shutter in a culvert near Gulzarbagh station was carried away at night. Thanks to the efforts of the Public Works staff and the District Board staff, the opening was, however, closed quickly and no serious damage was done to Patna City. The re-opening of the dead river Panchane caused some flood in Bihar Shariff.

No loss of life was caused by this flood anywhere and the district staff, both in Patna and Gaya, ably assisted by the District Board staff, supplied immediate relief to those who required it. Government have sanctioned Rs. 5,000 for the relief of distress in the flood affected areas in these two districts.

It is too early to anticipate the final state of the main paddy crop in any part of the province. But it can be said that the rain came in time to permit transplantation in most parts and where it was too late, the Agricultural Department has been taking steps to provide seed for a quick ripening broadcast variety of paddy, especially in the Gaya district. If the rains continue to be satisfactory up to and through the *Hatia Nakshatra*, there is no reason to expect any serious shortage in the paddy crop in any part of the province. The sugarcane is reported to be in good condition in practically all parts of Bihar.

Locust Pestilence

A recent press report says that according to an expert connected with locust research work at Karachi, India is threatened with another locust cycle. Since July 12, it has been discovered that sudden incursion of locusts has taken place from outside at Gwadar, Pansi, Khairpur State, Jaisalmer and parts of Bikaner areas. Reports from West Sind show that a fairly good number of locusts are scattered over a wide area from Johi to Shahdakot. They seem to be present all over the Thar area. A few hoppers have also been noticed. At present locusts are too thinly scattered to admit of general control.

Locust research in India really began only about four years ago. The severe pestilence between the years 1926 and 1931 forced the attention of the Government and the public towards this serious problem and led to the formation of the Central Locust Bureau of the Imperial Council of Agricultural Research on the recommendation of its advisory board. This Bureau began to function in February 1930. As a result of research during the last four years both in the laboratories and in the fields, much knowledge has been acquired which will be invaluable in combating any locust cycle in future. In the past, India has suffered from locust cycles during 1869-81, 1889-1907, 1912-19, 1926-31.

Tropical Diseases

Lt. Col. R. N. Chopra the officiating Director of the Calcutta School of Tropical Medicine gives an account of the various investigations in tropical diseases carried out at the School in the annual report which has recently been published.

The chief subject under enquiry was cholera, which was carried out in co-operation with the All India Institute of Hygiene and the Central Research Institute, Kasauli—all working under a Central Committee under the Indian Research Fund Association. The value of cholera bacteriophage in the treatment of the disease was investigated at the Campbell Hospital, but further work is necessary to come to any final conclusion.

In the study of cholera carriers it is of the utmost importance to determine once for all the relationship between the true cholera vibrio which agglutinates with the anti-cholera serum, and the very widespread cholera-like vibrios which abound in the natural water supplies of Bengal, but which do not agglutinate with the specific serum. These non-agglutinable vibrios come into very great prominence during the decline of cholera epidemic and they may constitute a "carry-over" form of the vibrio, capable under suitable climatic conditions of initiating a new epidemic.

An inquiry into the cause and nature of hill diarrhœa was financed by the Endowment Fund.

and carried out at Darjeeling. The conclusions arrived at were that it is not a separate disease and was caused by the usual causes such as the extremely insanitary conditions under which food is sold in the crowded bazars of the hill stations.

The malaria transmission inquiry was continued to secure further data on the limits of the atmospheric temperature and humidity under which *Anopheles Stephensi* transmits malaria.

The kala-azar enquiry was continued on the bionomics of the transmitting sandfly and the best method of controlling it. Fight against adult insects has been found to be more successful than the anti-larval measures. The breeding grounds of the sandfly vary with the season. Their chief natural enemies are spiders and lizards. The problems of dermal leishmaniasis -a disease extremely prevalent in Calcutta and intimately connected with kala-azar were further studied. Elsewhere in this issue we publish a communication from Dr. P. N. Bramhachari on this subject. A good deal of scientific work was done in the department of skin diseases. The attendance in the skin outpatient clinic for the year was 24,780, though the department is open only two days a week. The treatment of leprosy with leprolin is being studied in the leprosy department, and also the value of the leprolin test in assessing the susceptibility of the patient. Attempts are also being made to cultivate the germ of leprosy in tissue cultures.

Pasteur Institute section has been completely decentralized, and 4.847 complete treatments were sent out during the year to the various treatment centres of the province. The hydrophobia rates after treatment are for jackal bite 1.56 per cent and for dog bite 0.33 per cent. Epidemic dropsy was closely studied. The Indian Research Fund Association made a further grant towards its study. A germ has been isolated which agglutinates against the patient's sera and the possibility of a protective vaccine and a serum for treatment lies ahead.

Besides the main lines of investigations mentioned above, scientific works in various other directions were also undertaken. Among these may be mentioned the studies on meningitis, larva eating fish, indigenous drugs, hookworm infection, anæmia and respiratory diseases in tea plantations of Assam etc.

The School is primarily a postgraduate institution, and during the year under review 75 doctors received special training in tropical diseases and 30 candidates were trained for the diploma of public health. The bulk of the expenditure on the School and on the upkeep of the hospital is borne by the Bengal Government, though it receives valuable helps from outside. The Rockefeller Foundation awarded two new research fellowships to members of the staff and extended the fellowship of a third for one year. The Indian Research Fund Association financed in part or wholly 11 inquiries at the School on cholera, kala-azar, leprosy etc. It also paid for two professorships at the School. The Endowment Fund of the School which is susidized by the great commercial organizations of India, and specially the Indian tea, jute mills, mining associations and Indian Railways, financed eight enquiries. Health propaganda work was undertaken under a grant from the Calcutta Corporation.

Retirement of Lt.-Col. A. D. Stewart

Lt.-Col. A. D. Stewart, C.I.E., M.B., D.P.H., D.T.M. & H., F.R.C.S.E., Director, All-India Institute of Public Health and Hygiene, Calcutta, whose retirement was recently announced, entered the Indian Medical Service in 1906, having qualified from Edinburgh University in the same year. He saw much active service during the Great War, and afterwards from 1919-1921 served as the Medical Officer of Health, New Delhi. In 1921 he came to Bengal and served in turn as Director of the Bengal Public Health Laboratories, Director of Public Health, Bengal, and Professor of Hygiene at the Calcutta School of Tropical Medicine. In 1926-1928 he was appointed Principal of the Calcutta Medical College, and had a very strenuous time in reorganizing that institution and putting it on a sound basis.

In 1929 the scheme for an all-India Institute of Hygiene and Public Health matured, and the construction of the building and its equipment were undertaken by the Rockefeller Foundation at a capital cost of Rs. 16 lakhs. Lt.-Col Stewart was selected as Director-Designate of the Institute in 1929, and in 1932 became its first Director.

For twelve years he has been a Fellow of the Calcutta University, and served for a long time the

State Medical Faculty of Bengal, the Bengal Council of Medical Registration &c. He is a Foundation Fellow of the National Institute of Sciences of India, and a member of its Committee on Physiology.

Lt.-Col. Stewart has published many papers on public health and medical research subjects in the *Indian Medical Gazette* and the *Indian Journal of Medical Research*. He was the author of manuals on tropical hygiene and public health laboratory practice. He received the C.I.E. in 1934 in recognition of his valuable services to India.

Lt.-Col. Stewart retires from India to take up the appointment of Superintendent of the Royal Infirmary at Edinburgh.

An Earthquake Commission for India

It is reported in the daily press that the Government of India is contemplating the appointment of an Earthquake Commission as suggested in SCIENCE AND CULTURE of July, 1935. The country will certainly welcome the appointment of such a commission, provided the co-operation of the intellectuals of the country who can organize and suggest scientific measures is secured. The Quetta Earth-quake caused the Government a loss of six crores of rupees. Nobody knows what has been the loss to the public. The Bihar Earth-quake of 1934 caused damage to property amounting to tens of crores. If a small portion of the amount which has been subscribed to the funds opened by H. E. the Viceroy and other public bodies for the two earth-quakes is diverted to the founding of an Earth-quake Research Institute, much useful research work which will ultimately lead to scientific knowledge of great use to the public may be anticipated. We appeal to H. E. the Viceroy for giving serious attention to the suggestion for the establishment of a Earth-quake Research Commission, with a Central Research Institute, and with the cooperation of scientific observers throughout the whole of the earth-quake belt.

In this connection we would like to draw the attention of our readers to an article on the Quetta Earthquake by Mr. W. D. West of the Geological Survey of India, appearing elsewhere in this issue, where the problem of earthquake research in India has been briefly discussed. Mr. West is the secretary of the sub-committee which has recently been appointed by the National Institute of Sciences to advise it on the seismological questions.

Alcohol as Motor Fuel

[The following letter from Dr. N. G. Chatterji of the Harcourt Butler Technical Institute, Cawnpore appeared in the *Leader* of 13-9-35. We reproduce the letter here as the subject is of great scientific and public interest.]

—In the Leader of Sept. 8, there appeared an article on 'The problem of profitable utilization of molasses', by Mr. Ram G. Shahani, of the department of Applied Chemistry, Benares Hindu University, in which the writer took great pains to show that the only solution to this problem lies in the manufacture of acetic acid. I have nothing to say either for or against this acetic acid manufacture in which quite a number of our university men seem to have become suddenly very much interested, especially after a favourable reference to it by the Imperial Council of Agricultural Research. The manufacture of acetic acid from alcohol is now a very common and standardized practice in every country in Europe, and alcohol for this purpose is issued to the industry at a low rate of duty after denaturing with acetic acid becteria.

The point however, to which I want to draw the attention of all, is the serious misrepresentation of facts regarding power alcohol, contained in the article in question, obviously due to want of recent knowledge on the subject by the writer. The figures regarding the cost of manufacture of power alcohol as quoted by the writer, are now acknowledged to be too high, for at that time first hand knowledge of the industry was not available in the country—a deficiency which, thanks to the foresight of U. P. Government, no longer exists. An expert committee was appointed by the local Government in June 1935, to examine thoroughly the cost of manufacture of power alcohol in U. P. This committee had also the opportunity to consult a French expert with the latest experience of erecting and working a distillery in India, and has come to the conclusion that with molasses at 5 annas per maund delivered at the distillery the cost of manufacture of denatured power alcohol in a moderate size plant would not be more than 6 annas per gallon. There is not much chance of the price of molasses going above 4 annas per

maund in the sugar factory areas, even if power alcohol becomes an established industry in the province. Incidentally it may be mentioned that the much advertised and long awaited molasses exporting concern has been reported to have offered a rate of 2 annas per maund for the purchase of molasses in the eastern districts of the United Provinces.

It has now been established beyond doubt that if the industry comes under one organization for the whole of U.P., power alcohol may be made available in the province at the same price as petrol and *without any preferential treatment meted out to it.* So far as U. P. is concerned the development of the power alcohol industry certainly does not depend upon the 'charity' of Government to reduce the excise duty and enforce the petrol concerns to mix alcohol with petrol. On the contrary, the power alcohol industry demands Government assurance of protection against any unfair competition by the petrol industry through an abnormal cut in the price of petrol. It must be assumed that the present market prices have remained the same even at a time when the price of every commodity had gone down considerably. To assume the contrary would be to charge the industry directly of the crime of profiteering and Government indirectly with connivance, as the industry is practically a monopoly of one company. Moreover, the indigenous petrol industry is being threatened with what is reported as foreign dumped petrol, so that a strong opinion in the country is forming to the effect that for the protection of the industry, legislation should fix a scale for the minimum sale price of petrol based on its average price for the last three or four years.

Given this legitimate protection against unfair competition, it is confidently expected that the power alcohol industry can be firmly established in U. P. As for the so-called drawbacks pointed out by Mr. Shahani against the use of power alcohol, they are more imaginary than real, if we are to rely at all on the extensive laboratory experiments carried out in Europe, and on the accumulated experience of the countries all over the world, where alcohol-petrol mixtures are in general use.

In conclusion, mention may be made of the fact that during the last two years, the production and consumption of Indian petrol have gone up by about 8 million gallons. All that the alcohol industry claims is its legitimate share in the expanded market, and only in those parts of India where the use of alcohol-petrol mixture would not entail any hardship on the consumer. But the quantity of molasses produced is so much that even if the use of alcohol blended fuel were made compulsory in U. P., Mr. Shahani may be assured that he would earn the deep gratitude of the sugar manufacturers if he were to take away even one-third of their quantity of surplus molasses through his acetic acid, the manufacture of which from alcohol is now a well-known and thoroughly understood process

Prehistoric Relics in Limbdi

Mr. M. S. Vats, Superintendent of Archæology, Western Circle, is reported to have discovered ancient pottery and other valuable pre-historic relics in Limbdi State, Kathiawar. Early in the year Mr. Vats sunk some trial pits at selected sites and soon came upon painted pottery, wins, beads and other relics which are said to belong to a period equivalent to the third millennium strata discovered both at Mohenjo-daro and Harrappa. As he suspected that the place was used more as a halting station on an ancient trade route than as a regular place of settlement, he took his finds to Poona for closer examination, the result of which will be awaited with interest.

Commenting on the finds of Mr. Vats, Dharma Vir Vishnu R. Karandikar, Hon. Secretary of the Narmada Valley Research Board says, " It is a wonderful testimony to the historicity of the Puranic tradition that evidence should so soon be forthcoming about ancient vestiges in this area " (Kathiawar). Mr. Karandikar thinks that it would be possible to find links with ancient foreign settlements all along this tract, especially along ancient trade routes, about which he says :

" According to this theory, the possible line on which similar vestiges will be found will be along the banks of the Narmada, between the Narmada and the Tapti rivers, to ancient Kundiarpur near Amraoti in the Berars. Very probably near Shukla-teerth, in the Broach district, the Narmada used to be crossed and the route went northward alongside the old sea-coast—about 25 to 30 miles inland, running almost

parallel to the present sea-face. The Gulf of Cambay was crossed at its northern extremity. This is the general outline of the important trade route running from the west coast across the Peninsula to the west taking on its way the fertile tract of the Berar and the Central Provinces.

"Similarly another trade route ran along the northern bank of the Narmada, passing through the old Begur district, Malwa and Rewa and then skirting the Amarkantak range, reached Jagannath Puri. This route was under the spiritio-commercial protection of the Markandeya Clan, which had over ten different centres along this road."

Need for a critical Edition of the Mahabharat

That there is a very great need for a critical and authoritative edition of the *Mahabharata* cannot be denied, and it is well that the Bhandarkar Oriental Research Institute, Poona, have taken upon themselves the task of meeting it by bringing out such an edition, the *adiparvam* of the great Indian epic having already been published. This task is no doubt "a marvel of gigantic toil and philological accuracy which marked one of the most important events in the history of Sanskrit philology since the publication of Max Mueller's *Rig Veda*." In a lecture on the text problem of the *Mahabharata* delivered sometime back at Dacca, Dr. S. K. De, one of the collaborating editors of the edition of the *Mahabharata* brought out by the Bhandarkar Research Institute, emphasized the need for such an edition. Those previous to it were mainly based on the current vulgate text, and they had therefore failed to satisfy the exacting demands of modern critical scholarship or remove the many textual uncertainties. These were necessitated not only by an oral transmission of the text but also by certain abnormal circumstances resulting in an amazing fusion of different versions as well as the creation of sharply differentiated types. Not only were there two recensions of the epic diverging widely from each other, but there were no less than a dozen subdivisions which were however strangely contaminated with one another and made the text problem all the more complicated and difficult. Now that the Bhandarkar Oriental Research Institute have set seriously to reconstructing the text by a comparative examination and estimate of the diverse versions and recensions with the collaboration of a band of sound scholars of which Dr. De is one, we have no doubt that they will really do a great good to the oriental scholarship

Problems of Indian Coal Industry

In his presidential address to the 11th Annual Meeting of the Geological, Mining and Metallurgical Society of India, Mr. M. M Mukherji discussed the various problems that the Indian coal industry is facing to-day. The extreme depression in the industry he ascribed to

(i) General economic depression,

(ii) Increase of oil burning motor ships,

(iii) Greater use of oil in some Indian mills,

(iv) Progress of electrification of mills and factories.

As one of the immediate steps to remedy this situation he suggested the closing down of Railway Collieries. He deplored the waste of fine grade coal in railways etc., which could otherwise be very usefully employed in special metallurgical processes. He sought the co-operation of the Government for encouraging the export trade in coal by foreign propaganda etc. Mr. Mukherji thought that the recent adoption of the convention by the International Labour Conference for the total prohibition of women underground would adversely affect the Indian coal industry. He concluded:—"In my last year's Presidential Address, Gentlemen, apart from making other suggestions, I tried to impress upon you, on the Government, and on the colliery owners the necessity of extensive and intensive researches for ascertaining the suitability of the many different varieties of Indian coal for various special purposes. But the steps taken so far, I am sorry to say, are too inadequate to meet the end. I, therefore, appeal to all concerned to give this important aspect of the Industry their serious thought as it deserves."

Report of Agri-horticulture Society of Madras

"The object (which is, as set forth in the rules and regulations, the promotion of agriculture, arboriculture and horticulture) was perhaps never more rigidly and scrupulously sought to be fulfilled than in the year under report as the introduction of new plants of merit practically from all parts of the

world and their propagation and distribution formed one of the main activities during the past twelve months", so said Mr. B. S. Nirodi, Hony. Secretary of the Agri-horticulture Society of Madras at its Centenary Meeting held on August 7, 1935, under the presidentship of His Excellency Lord Erskine, in presenting the annual report of the Society.

Among the achievements of the Society during the year under report may be mentioned the introduction and successful cultivation of 12 large flowered tropical *Nymphasas* (water lilies) from U. S. A., the institution of a training class for practical gardening for the encouragement of which the Government awarded ten scholarships of Rs. 5 each, and a considerable extension of the area under cultivation in the nursery garden with a view to provide more room for experimental plantings and the raising of cut flowers the demand whereof is increasing. The Governor expressed his gratification at the sound financial position of the Society and congratulated it on its excellent record of work.

Agricultural Research at Tindivanam

Economic spacing *i.e.* the proper seed rate for different types of oil seeds, the suitable rotation and manuring of crops so that the fertility of the soil is not further depleted, and the production of disease and drought resistant varieties—these are some of the problems which the recently opened Agricultural Research Station Tindivanam, Madras, has set itself to tackle. In 1917 the Agricultural Department acquired a private cocoanut garden which was yielding at the rate of 35 nuts per tree, but which has by systematic cultivation and manuring doubled the yield. About 1,000 cross-bred palms have recently been planted as an experiment to find if the yield is appreciably increased. Investigations as to the quality of oil, the rate of its formation &c. are proceeding, as well as those of a genetical nature, these latter being meant to determine the difference in characters and traits between any two generations of plants. Investigations to discover the number of chromosomes go tog show that their number in the pollen of groundnuts is 20, cocoanut 16, til 13, niger 14, and castor 12. Important researches on the flowering phase of these crops are also being carried on.

Hæmaturia in Cattle

The following *communique* was issued by the Agriculture and Industries Department, Veterinary Branch.

"In the *communique* on the subject of Mr. A. D. MacGregor's investigations into the cause of hæmaturia in cattle (published on March 7 last) it was stated that the conclusions reached by Mr. MacGregor as the result of his investigations had not been endorsed by the Director of the School of Tropical Medicine or by the Helminthologist.

"The reason for this was that the materials collected by Mr. MacGregor had not at that time been placed before either.

"Since then, however, the flukes and fluke-eggs discovered by Mr. MacGregor in the pancreatic ducts and fladder walls of affected beasts and identified by him as trematodes have been subjected to independent examination by Dr. Naplestone, Helminthologist of the School of Tropical Medicine, who has confimed Mr. MacGregor's identification of the flukes as being a Eurytrema species and the eggs as almost certainly those of the same flukes."

Mr. A. D. MacGregor, I.V.S., is the Principal of the Bengal Veterinary College, Belgachia.

Electric Schemes of the Madras Government

Recently Sir K. V. Reddy, Law Member to the Government of Madras, announced that the Government was contemplating to start a scheme costing about Rs. 30,000,000 for three generating stations in the Andhra districts, namely at Nizagapatam, Bezwada and Guntakal. The Government intended to instal a thermo-electric station at Vizagapatam which would supply both water and electricity to towns and villages in its vicinity.

Toll of Malaria in Ceylon

According to the report of Col. Gill on the malaria situation in Ceylon, submitted to the Executive Committee of Health, the toll of the scourge in 1934 amounted to nearly 38,000 lives in three months. The Government have already for the purposes of relief spent Rs. 40,00,000, and another sum of Rs. 15,00,000 has been provided in the next Budget. The epidemic of 1934-35 was unprecedented in magnitude and intensity. Col. Gill believes that the next

cycle of the epidemic will take place in 1940 or so, which will however be of much lesser intensity.

Marble Deposits in the Frontier

Under the scheme of trans-border development initiated by the Government of India, the marble deposits in the Mullaghuri country at Shahid Mena in Lower Tirah are being exploited.

The frontier marble has been reported on by the Geological Survey as equal to the best Italian marble and already orders to the value of Rs. 30,000 have been booked. One hundred tribesmen are now being taught quarrying under the direction of a quarryman from Rajputana.

The marble will be sawn and polished at a factory being erected near Peshawar City railway station. As there is scope for its use for ornamental plates, bowls and similar objects, two skilled workmen are teaching Afridi boys the art of cutting marble at the school at Lower Mena.

Colonel E. W. C. Noel, Director of Agriculture and Allied Subjects in the Frontier Province, who is the moving force behind all the schemes being introduced for the amelioration of the condition of the tribesmen and agriculturists, anticipates that it will be possible to sell marble to the value of Rs. 1,00,000 a year.—*The Statesman.*

Snake Venom for Hæmophilla

According to a newspaper report a consignment of 29 Indian snakes was sent to London Zoo from India. Of these 29 snakes, nine are Russel vipers which will provide the research laboratories with an occasional dose of their deadly venom which is used in a dried and sterilized form for treating cases of Hæmophilla, a mysterious disease of the blood.

Increase in air Traffic

A continued rapid increase in air traffic is shown by the figures for passengers, freight, mails and mileage of Imperial Airways' services.

Comparing the first quarters of this year and of last year, passenger ton miles were 564,835 as against 367,038, freight ton miles were 127,213 as against 87,811; and mail ton miles were 269,425 as against 135,056; while the passenger mile total reached 5,884,234 as against 3,830,609.

Still more recent statistics, referring to May of this year, show an increase of 70 per cent, as compared with the corresponding period in 1934 in the number of Empire air passengers passing through Croydon air port.

During the most recent 12 months for which figures are available—March 31, 1934 to April 1, 1935—the air liners of Imperial Airways operating on European and Empire routes flew 2,482,864 miles and carried 55,559 passengers and over 2,000,000 lbs. of mails and freight.

Canned Fruits

The Imperial Economic Committee reports that imports of canned fruits preserved in syrup during the year 1934 were a record at 173,000 tons. The proportion of the total supplied by British countries, continuing the rising tendency of recent years, was also a record at 44 per cent.

Archaeological Finds

The archæological excavations at Patna (referred to in the August issue of SCIENCE & CULTURE, p. 149) which were started in 1934 and will probably continue for a year more have already led to the discovery of many relics of the Mauryan and pre-Mauryan epochs. These excavations have been hitherto conducted in three sections. The *first* is at the western extremity of the old town and underlies the Kadamkuan-Bakerganj-Sabzibagh area; the second is towards the east under Bhiknapahari and Musallahpur going up to the Engineering College at Golakpur; and the third section falls midway between Ramna and the Senate Hall. It is said that excavations in the last section resulted in the discovery of 44 silver punch-marked coins declared to be very early specimens. What is of great interest and value to the archæologist is the reported find of a terra-cotta plaque of fine workmanship said to contain the figure of the Sun-god and his charioteer standing on a chariot drawn by four horses. There have also been unearthed at Bakergunj a punch-marked copper coin, a large number of earthen dishes, pots and jars (ranging from 1 inch to 3 ft. in diameter) and numerous toys. It is reported that terra-cotta horses, from the crude to the developed forms, have been discovered, in addition to diminutive elephants, also of both crude and advanced forms, some of which are coloured in black

and red. A beautifully designed stone-wheel of a diameter of about 3¼ inches, containing an inscription on it which has been deciphered to read 'Vishakhasha', is also said to have been unearthed. In addition to these the finds contain numerous terracotta figures, toy animals, earthen dishes and many other ancient relics, which will doubtless prove to be of vast interest to the archæologist. We trust that they will throw considerable light on an important period of the ancient Indian history.

A Buddhist *stupa*, believed to have been erected in the Mauryan period (4th and 3rd centuries B.C.), has been discovered at Lauria Nandangarh, in Champaran district.

The mound which is situated close to the Asoka Pillar in the locality, was discovered during digging operations for a sugarcane plantation.

Experts believe that further excavations at the site may lead to the discovery of relics belonging to the pre-Mauriyan period.

The Superintendent of Archæological Survey with the Government of Travancore, has been placed in possession of two copper-plates, which may be said to belong to the 15th Century. The engravings, it is stated, are not the same as those on the other Mitranandapuram plates.

The first plate contains separate inscriptions on each side. The inscriptions relate to the reign of Veera-kerala Marthanda-Varman, while the plate records that when Jupiter was in *Makaram* some lands were given for worship in the Mitra-anandapuram Temple. The Second inscription records that when Jupiter was in *Vrischigom* Sankaranarayanan and Sankara magalattu-Devanarayanan gave some land for worship in the Mitranandapuram Temple, and that Devan Zupper of Sankaramangalam and Sankaran would receive the land and protect the temple.

The second plate which is broken records a gift of land to the Pattarakkar of Mitranandapuram by Ettaray assembled in conference.—*The Statesman*.

News has reached us that a new set of three Rashtrakuta copper plates with a ring and seal was recently discovered by Professor V. V. Mirashi of Morris College, Nagpur. The plates were issued by the Rashtrakuta King Govinda III from his victorious camp at Mayurakhandi on the occasion of a solar eclipse in the expired Shaka year 722 and record the gift of a village named Anjanavati near Achalapura now in the District of Amraoti (Berar) to a number of Brahmins. The corresponding English date is June 25, 800 A.D. and it is held that Achalapura is the modern Ellichpur in Berar.

Govinda III was a famous king of the dynasty and flourished between the years 794 and 814 A.D.

Prophylactic Action of Vitamins A and D

Regular administration of Vitamins A and D shows a consistent lowering in the rate of sickness absence. The investigation was carried out among a group of 300 employees of Lever Brothers, Ltd. at Port Sunlight in 1933-34, a group of 300 men who did not receive the extra vitamins forming a control group. The results showed that group taking the vitamins was less susceptible to influenza, bronchitis and colds than the control group.

Photo-Chemical Decomposition of Food

In order to prevent the deterioration of food due to the action of light, air and bacteria, chemical antiseptics are usually employed. But these are undesirable from the standpoint of health. Researches carried on by food specialists in England and the U. S. A. during the last two years have definitely proved that the photo-chemical decomposition of fatty goods such as oil, butter, lard, biscuit etc., can be prevented to a great extent by using red and green wrappers (Cellophane) or bottles. The rate of rancidity was lowest with red and most pronounced with orange, the relative rates of decomposition being as follows: Red 1.1, Green 1.65, Blue 2.6, Yellow 5.0, Orange

New Uses for Straw

The Ukraine Cereal Institute of Russia has elaborated a process for producing sugar, alcohol and fodder yeast from straw. Large scale experiments are now proceeding.

Gasoline from Coal

A large factory for the hydrogenation of bituminous coal by the I. G. Farbenindustrie's process is

being erected at Scholven in the Ruhr area in Germany. The plant is expected to yield 125,000 tons of benzine per year.

Meteoric showers

Dr. A. L. Coulson reports as follows on—*Additional Stones from the Perpeti Meteoric Shower.*

Since the August meeting of the Asiatic Society of Bengal, when eleven stones which fell in villages under the jurisdiction of Chandina police station during the Perpeti meteoric shower of the 14th May, 1935, were exhibited (see SCIENCE AND CULTURE, I, No. 4, p. 194), three additional stones, of a total weight of 1,531.604 grams, have been recovered by the District Magistrate from villages under the jurisdiction of Kachua police station in Tippera district. The total weight of all specimens recovered from this shower now amounts to 23,474.18 grams.

One of the three additional stones (298 L) is extremely interesting in being the sole specimen of the shower which shows a secondary crust. This has been developed on two of its faces by their imperfect fusion after their formation as a result of a secondary disruption of the stone in its passage through the earth's atmosphere. The contrast between the generally smooth, thin crust characteristic of all the stones of the Perpeti shower and the coarse, dark, rough, secondary crust on these faces of 298 L is very marked.

The smallest of the three additional stones is an almost perfect crust-covered specimen. An imperfectly developed system of radiating flow lines is developed on the crust of one face. These are due to the effects of surface air currents upon the fused surface of the stone during its flight towards the earth.

It would appear that the stones of the Perpeti meteoric shower fell within a rectangular area some five miles long by three miles wide, the supposed direction of flight of the parent meteor being in the direction (south-west to north-east) of the shorter side.

The three additional stones were exhibited at the September meeting of the Asiatic Society of Bengal in Calcutta, with the permission of the Director, Geological Survey of India.

Following lightning and thunder, but no rain meteoric stones weighing as much as 52 lbs. fell at a village near Comilla. They are black and appear to be composed of iron and lead. The District Magistrate has ordered that they be sent to the Geological Survey of India.

Announcements

The Nawab of Bhopal has accepted the invitation of the Allahabad University to address the next convocation of the University on December 5.

It is understood that Sir T. B. Sapru will deliver the next convocation address of the Patna University.

Lt.-Col R. N. Chopra, I.M.S., the Professor of Pharmacology in the School of Tropical Medicine, Calcutta and its officiating Director, has been appointed to officiate as Surgeon-General with the Government of Bengal, in place of Maj.-Gen. D. P. Goil who has gone on leave.

Mr. Lionel Fielden, late of the B. B. C., has been appointed Controller of Broadcasting, relieving Mr. P. J. Edmunds, Director of Wireless, of his additional duty.

Sir Josiah Stamp, statistician and the chairman of the London, Midland and Scottish Railway has been nominated the President of the British Association for the Advancement of science for 1935 by the Council of the Association.

It is reported that a Smithson Research Fellowship open to British subjects, including subjects of the Overseas Dominions and Colonies, and of the Indian Empire, will be awarded by the Royal Society of London, with effect from January 1, 1936.

The object of the Fellowship is to promote "research in natural science, with a view to the discovery of new laws and principles, rather than with the exploitation of what is known."

The rules governing the award state that the appointment will be made for four years in the first instance, but may be renewed for further periods of one year each up to a maximum total tenure of eight years. The stipend will be at the rate of £800 a year during the first two years' tenure of Fellowship, but may subsequently be increased up to a limit of £900.

Under normal conditions the Fellow will be required to carry out his research in the University of Cambridge, and, if not already a member of that University, to acquire membership.

Applications must be received at the offices of the Royal Society at London not later than October 31, 1935.

Irrigation Problems in Bengal

Elsewhere in this issue we publish the concluding portion of the article on Irrigation Problems in Bengal by Mr. S. C. Majumdar who is eminently fitted to write on this subject, having as he has, a long first hand knowledge of irrigation problems both in Bengal and other provinces. Here we would like to draw the attention of our readers to a few points touched in that article. Mr. Majumdar has recommended storage of water in Western Bengal as this will be very useful for irrigating *rabi* crops. Bengal now imports most of her oilseeds and some *dal* which are *rabi* crops. The author's proposal is therefore entitled to serious consideration, as thereby the area would be able to raise a double crop in the year.

As regards the proposed dam across the Mourakhi at Mossanjoro for irrigating the paddy fields of Bankura and Burdwan districts, we would like to mention that after the catastrophic flood of the Damodar in 1913, the Bengal Government appointed an irrigation officer to enquire into the possibility of having a storage scheme in the Chotanagpur Plateau for the Damodar. The scheme was submitted, but no action was taken on it.

The author thinks that as long as the voluntary basis of the present Act remains, it will be difficult to make irrigation projects financially sound. Here the Bengal Government may follow Egypt where the irrigation tax has been incorporated in the land tax.

The rise in river beds due to embankments is a serious problem in Bengal. In U. S. A. too, the white settlers by embanking the Mississippi during the last 150 years have created a similar and a very serious situation.

Mr. Majumdar states that the diversion of the Ganges flood through the Padma channel occured in the 15th or 16th century. He will do a great service if he can tell us from the records at his disposal as to when this diversion took place. Ta Vernier, travelling in Bengal in 1676, says that one cannot proceed from Cossimbazar to Saptagram by boat during dry season the river was navigable below Saptagram only as now. The Saraswati died in about 1600, as a consequence of which, Saptagram was abandoned and Hughli became the main river port of lower Bengal.

As regards the oscillation of river channels in the course of delta building we would like to ask what is the scale of time required by the river to go through a complete cycle. Supposing that the diversion of the Ganges through the Padma happened in the 1400 A.D., the cycle is only half way through in 500 years; and naturally mankind can not wait for such sub-geological epochs. Mr. Moore's estimate of a decade for this period seems to be too optimistic. Many decades have since passed and the rivers show no tendency to improve.

In connection with the cost of upkeep of the Hardinge bridge, we would like to say that the original estimate for its construction was 2.7 crores. The actual expenses went over 4 crores. But since its erection, over two crores have been spent for preserving it against the Ganges floods. All this is due to faulty planning!

The author has recommended the improvement of the outlet of the Mathabhanga. This was recommended by Sir W. Willcocks seven years ago, and the Irrigation Department was so far roused as to make a heroic attempt. But if rumour goes correct, the dredgers which were bought for the purpose were too big for the river channel.

Mr. Majumdar informs us that in the olden days, when the Bhagirathi was in a better condition, Calcutta was directly connected by water with the Ganges. We shall be glad if Mr. Majumdar can quote actual authority for this statement. Even in 1676, according to the statement of French travellers, ships could not pass from the Bay of Murshidabad, but had to stop at Triveni, and goods were carried in small country boats to Cassimbazar the chief silk-market of those days. It may only be said that the Bhagirathi has further deteriorated, so that now even country boats cannot pass from the Bhagirathi to the Ganges during the dry season.

Retirement of Sir T. Vijayraghavacharya

The retirement of Dewan Bahadur Sir T. Vijayraghavacharya, K.B.E., Vice-chairman of the Imperial Council of Agricultural Research, has been recently reported in the press. Born in August, 1875, he was educated in the Presidency College, Madras, and in 1898, joined the Provincial Service. He served the Government in various capacities such as Secretary to the Board of Revenue (1917-18), Director of Land Records (1918), Deputy Director of Industries (1918-19) &c. He was the Commissioner for India, British Empire Exhibition (1922-25), Member of the Legislative Assembly (1925-26). In 1926 he served as the Director of Industries and also of Fisheries, opened the Canadian National Exhibition in August of the same year and served as a Member of the Public Service Commission from 1926 to 1929, when Imperial Council of Agricultural Research came into existence and he was appointed its first Vice-Chairman. We wish the Dewan Bahadur a long peaceful life of rest which he so immensely deserves.

Retirement of Dr. Arnold Berliner

The *Naturwissenschaften* of 30th Aug., 1935 reports that Dr. Arnold Berliner who along with C. Thesing founded the *Naturwissenschaft* in 1913, and has since been working as editor and publisher has retired form his charge. Dr. Berliner's object in founding the journal was to bring together the representatives of the numerous branches of Science on one common platform, and make them understand each other, and thus advance the cause of science. This object was largely achieved through Dr. Berliner's efforts throughout the last quarter of a century, who piloted the journal with great success through periods of stress during the war, and the post-war times. He was thus greatly successful in furthering the mutual understanding between workers in different lines.

In recognition of his services to science, Dr. Berliner was awarded the Leibnitz Medal of the Prussian Academy in 1928.

The present editor of the journal is Dr. H. Matthee.

Medical Service and Public Health in U.S.S.R.

The *Science* of Aug. 16, 1935 reports a lecture by Alexander A. Troyanovsky, Ambassador Extraordinary and Minister Plenipotentiary to the U. S. A. of the U. S. S. R. about the progress in Medical Training and Research in Russia during the Soviet Regime. According to the speaker, terrific annual toll in human life used to be exacted from the Russian population by social, epidemic and other diseases before the War. Owing to enlightened measures of the Soviet, the mortality has been reduced by one-third and the infant mortality has been halved. The population has increased by thirty millions since 1918. In the whole of Russia, there were only 20,000 doctors before 1918, now the number is 80,000. Medicine is under the charge of the General Commissar for Health, with whom co-operates the Commissariats for seven associated republics. The department works on a principle of Health Insurance for the public, *i.e.* 90 per cent of the physicians are state servants, and their patients receive free treatment in the hospitals and dispensaries which are also state institutions. They are employed in the hospitals, polyclinics, dispensaries, factories and district health stations, and so on that make the public health system. They are paid regular salaries and are required to work for 3½ to 6 hours. Outside office hours, they are allowed private practice.

In considering the organization of Soviet medicine, it should be borne in mind that there is no separation between the administration of public health and the administration of medical service, and no separation between curative and preventive medicine. The state considers itself responsible for the health of each individual and the community. The Soviet doctor is removed from the field of monetary competition, and from the necessity of collecting fees from the individual, so that he can devote his time to search out and discover means for abolishing diseases.

Unified Polyclinics : In the regular health system there are of course the general and specialized dispensaries and hospitals, the mothers and babies' centres, the venereal and tuberculosis centres, the factory and district health stations, numerous sanatoria and so on.

But this new type of institution is developing in all the larger centres and bids fair to be the main type of health institution of the future. These centres are well staffed with diagnosticians and specialists in the chief branches of medicine and actually

take over the supervision of the health problems of an entire district. They are supposed to locate the foci of morbidity and industrial causes of disease and carry out the necessary prophylactic measures. They are responsible for inspection of homes, food and water supply as well as the medical treatment of the individual and his health education, and for healthy conditions of work in the factory or individual establishment.

Night Sanatoria : An interesting development is the night sanatorium for treatment of workers with a tendency to tuberculosis or some other incipient trouble. Here the patients are taken for definite periods to be built up by special care and diet under medical supervision while still at their job.

Day Prophylactoria : These are for school children who need special care. Special care is also taken in these for prospective mothers during the period of pregnancy.

Abortion Centres : Abortions have been legalized in the Soviet Russia, but they must be performed by authorized physicians and under hospital conditions. Contraceptive knowledge and materials have been made freely available through clinics as a preferable method of family limitation.

The rest of the lecture deals with medical training of prospective doctors.

Research Notes

Studies on the female gametophyte in Solanaceae

In a recent issue of the *Journal of the Indian Botanical Society* (*11*, p. 133-149, 1935) Mr. P. N. Bhaduri has studied the comparative devolopment of the female gametophyte of (12) twelve species of solanaceae. In this paper he noted the 'Normal' type of gametophyte in each case, and did not agree with Nanetti and Young, who found 'Lilium' type of development of the embryo-sac in *solanum muricatum* and *S. tuberosum* respectively. He also found a transition from anatropy to campylotropy in the ovules of the tribe *Cestreae* and noted for the first time the presence of starch granules in the mature embryo-sac of *Cestrum*. His observations further show that the dimension of the egg is constant in all the species except in *Cestrum* and that more than one megaspore mother cell and one embryosac in the same ovule are common in the family.

G. P. Majumdar.

Thiochrom and Vitamin B_1

A highly important contribution on a yellow pigment obtained from yeast has recently appeared from the laboratory of Prof. Richard Kuhn of Heidelberg (Kuhn, Wagner-Jauregg, van Klaveren and Vetter, *Z. physiol. Chem.* *231*, 196, 1935). The authors have succeeded in isolating this pigment (20 mgm. from 1200 Kgm. of yeast), which contains sulphur and has been called "thiochrom". Its formula is given as $C_{12}H_{14}N_4OS$ and the apparently significant fact is pointed out that it contains 2 hydrogen atoms less than vitamin B_1, for the purest preparations of which the formula $C_{12}H_{16}N_4OS$ has been given (Windaus). A close chemical relationship between the two substances is thus indicated and the pigment is provisionally considered to be a dehydro-vitamin B_1. The pigment dissolves in water with a blue fluorescence. It may also be pointed out that Peters has already shown that blue-fluorescing solutions may be obtained by the oxidation of "pure" vitamin B_1.

B. C. G.

Temperatures below 1°K by Adiabatic Demagnetization

It may be recalled that Giauque independently of Debye suggested in 1927 that temperatures below 1°K may be obtained by adiabatic demagnetization of suitable paramagnetic substances. While he was busy in perfecting an experimental arrangement to utilize the process, the Cryogenic Laboratory at Leyden and the Clarendon Laboratory at Oxford were also working on the same idea. Indeed, de Haas and others at Leyden were the first to claim to have reached a temperature of about 0·27°K by adiabatically demagnetizing CeF_3 at an initial temperature of 1·26°K in a field of 31 Kilogauss. Following his earlier publications in 1933 on the nature of results obtained by him at California, Giauque gives in the July issue of the *Journal of the American Chemical Society* (*57*, No. 7) details of the method and apparatus used by him in the first exploratory and successful experiments. Using Gadolinium sulphate octahydrate crystals he reaches a temperature of 0·242°K when the initial temperature was 1·29°K and the field 8000 Gauss. Exact equations permitting the determination of thermodynamic temperatures corresponding to magnetic susceptibilities are also given. These equations are used to extend the Curie Scale to the determination of temperature from differential susceptibility measurements in the presence of a magnetic field. The inductance bridge used by him is claimed to measure temperatures with a 'precision of about 0·0003° in the extremely low region where it is used.

D. P. R. C.

Dentition of Eocene Primates

In continuation of the series of studies on the Evolution of Dentition among the Primates, Dr. M.

Friant, Professor of Zoological Anthropology, École d' Anthropologie de Paris, has contributed to *Revue anthropologique*, Janvier-Mars, 1935, another important paper entitled 'L' évolution du type primitif des molaires supérieures chez les Adapidés" (The evolution of the primitive type of upper molars among Adapidae). The paper in question is an attempt to examine the upper molars of two fossil groups of the genus Adapidae—Notharctinae (of North America) and Adapinae (of Europe) with the view of considering their trends of evolution specially regarding the arrangement of tubercles in them. Almost all the species of Adapidae so far available have been subjected to critical examination, and it is interesting to note that the author has got ample clear evidences, as has been beautifully illustrated in Fig. 10 of the article, of gradual simplification particularly in the arrangement of tubercles in their molars. The persistence of primitive type having 6 tubercles (2 externals, 2 intermediaries, and 2 internals) has been, however, observed only among Notharctus, Proto-Adapis, Adapis rutimeyeri Stehlin, who are certainly the primitive members of Adapidae. But the aforesaid simplification began to evolve with Pelycodus in which, unlike Insectivora, the postero-internal tubercle became less visible and came close to antero-interior; the intermediary tubercle, chiefly the posterior, was diminished in importance. It, however, reached its finality in the more evolved Adapidae among which the postero-internal tubercles became not only less important but ultimately separated from all other while the intermediary tubercles were obliterated "simultaneously, or rather more often successively, beginning from the posterior". This at once tends to confirm the author's previous observations regarding the evolution of the primitive type of molars among tarsoidae.

J. K. Gan.

Applications of Anthropometry by Rectilinear Coordinates.

Professor L. Nicolaeff of the University of Kharkov has explained in *L' Anthropologie 45*, 320-45, 1935, the practical usefulness of anthropometry to manufacture. He was employed by his Government to obtain mean measurements of human foot in Ukrain for standardized shoe manufacture. With the help of his specially made 'anthropometre à support' he took the mean contours of feet of 17,510 subjects, and elaborated rational types of forms for shoe manufacturers. Similarly he also took mean contours of the back and of the trunk and also applied his methods to the study of skulls. Everywhere precision was arrived at with the help of rectilinear coordinates in a simple way capable of rapid and exact execution and useful for various purposes. The study of skulls by rectilinear co-ordinates is very useful—the extension of the method to the living and the comparison of mean contours open up infinite possibilities of mathematical analytical treatment of the data. The simple instrument devised is also highly commendable and it has made possible the use of anthropometry to all manufacturers of standardized articles for human wear.

P. Mitra.

University and Academy News

National Institute of Sciences, India

Election of New Fellows

At a meeting of the Council of the National Institute of Sciences, India, held on Aug. 23 in the rooms of the Asiatic Society of Bengal, the following were recommended by the Council to be Fellows of the Institute. It may be mentioned in this connection that the National Institute is to elect every year 10 Fellows according to a system of rules based on those of the Royal Society of London. But in the first year, 26 Fellows are elected in deference to a resolution passed by the General Committee of the Indian Science Congress in its 23rd Session, held at Calcutta on January 5, 1935.

Guy Bomford, Captain, R.E., Survey of India. Dr. Bomford is the author of 13 papers dealing with survey and geodetic problems, (3 jointly with Dr. de Graaff Hunter). He is the originator of the conception of the compensated geoid, and of a method of computing the geoidal rise due to topographical and geological features.

S. R. Bose, M.A., Ph.D. (Cal.), F.R.S.E., Professor of Botany, Carmichæl College of Medicine, Calcutta.

Dr. Bose is the author of about 43 papers principally on Fungi. He is one of the leading authorities on Fungi.

William Burns, D.Sc., I.A.S., Director of Agriculture, Bombay; Late Assistant Lecturer in Botany, Reading, (1907 08); Economic Botanist to Bombay Government and Professor of Botany, Poona Agricultural College (1908-33); Principal, Poona Agricultural College in addition (1922-33); Joint Director of Agriculture (1926-27).

Dr. Burns has worked principally on the mango, the fodder grasses and grasslands of the Bombay Presidency.

S. N. Ckakravarti, M.Sc. (Lucknow), D.Phil. (Oxford), Professor of Chemistry, Annamalai University, Dean of the Faculty of Science, Annamalai University.

Dr. Chakravarti is the author of about 18 papers on synthesis of organic compounds, and on analysis of Indian medicinal plants.

Gouripati Chatterji, M.Sc., Meteorologist-in Charge, Agra Upper Air Observatory.

Mr. Chatterji is the author of about 6 papers himself and about 4 others (in collaboration) on upper air instruments and on the meteorology of the upper air.

Bashambar Nath Chopra, D.Sc., F.L.S., Asst. Superintendent, Zoological Survey of India, Calcutta.

Dr. Chopra is the author of about 23 papers dealing with Bopyrids, Stomatopods and crabs, May-flies and other families of insects.

A. L. Coulson, D.Sc., D.I.C., F.G.S., Asst. Superintendent, Geological Survey of India.

Dr. Coulson is the author of 5 geological memoirs and about 25 papers on mineralogy, petrography, meteors, and earthquakes.

Snehamoy Datta, M.Sc. (Cal.), D.Sc. (Lond.), D.I.C., Professor of Physics, Presidency College, Calcutta.

Dr. Datta is the author of about 19 papers on spectroscopy, of which 11 are joint papers.

J. A. Dunn, D.Sc., D.I.C., F.G.S., Asst. Superintendent, Geological Survey of India.

Dr. Dunn is the author of 2 geological memoirs and about 7 papers principally on economic geology.

S. B. Dutt, D.Sc. (London), Chemical Department, Allahabad University.

Dr. Dutt is the author of 67 papers on synthetic

organic chemistry, plant analysis and chemistry of dyes.

E. R. Gee, M.A. (Cantab.), F.G.S., Asst. Superintendent, Geological Survey of India.

Mr. Gee is the author of papers on the Geology of the Andaman and Nicobar Islands, on the Indian coalfields, on the Salt Range, and on landslides and earthquakes.

Prafulla Chandra Guha, D.Sc., Assistant Professor (acting as Professor) of Organic Chemistry, Indian Institute of Science, Bangalore; Late Lecturer and Reader in Chemistry, Dacca University.

Dr. Guha has shown great activity as a research worker, in several branches of organic chemistry, dealing particularly with organic compounds of sulphur, mercury and antimony, Michael's reaction, asymmetric syntheses, and the Walden inversion; compounds involving abnormal optical rotation, compounds related to bicyclic terpenes.

P. K. Kichlu, D.Sc., Professor, Government College, Lahore.

Dr. Kichlu has published 14 papers on spectroscopy. He has created a vigorous school of physical research at Lahore.

M. S. Krishnan, Ph.D., D.I.C., Asst. Superintendent, Geological Survey of India.

Dr. Krishnan is the author of about 12 papers on mineralogy and petrography.

R. B. Lal, M.B.B.S., D.P.H., D.T.M. & H., D.B., Ex-Fellow, Rockefeller Foundation; Member, Delta Omega Society of America; Professor of Vital Statistics and Epidemiology, All-India Institute of Hygiene and Public Health, Calcutta.

Dr. Lal has contributed 16 papers on epidemiology, in particular dealing with cholera, malaria, cerebrospinal fever, and ankylostomiasis.

Panchanan Maheswari, D.Sc., Lecturer in Botany, Agra College, Agra.

Dr. Maheswari is the author of about 15 papers, chiefly on the morphology of plants.

Mata Prasad, D.Sc, F.I.C., Professor of Inorganic and Physical Chemistry, Royal Institute of Science, Bombay.

Dr. Prasad has published a large number of papers on inorganic, colloid and photo chemistry and on structure of crystals.

Sundara Raj, M.A., Ph.D., Director of Fisheries, Madras.

Dr. Raj is the author of about 20 papers dealing with fish and fisheries.

L. A. Ramdas, M.A., Ph.D., Agricultural Meteorologist, Poona.

Dr. Ramdas is the author of 16 papers on the scattering of light, spectroscopy, interferometry, and allied phenomena, and about 19 papers on meteorology and agricultural meteorology.

Bidhubhusan Ray, D.Sc., Khaira Professor of Physics, Calcutta University.

Dr. Ray is the author of more than 30 papers dealing with scattering of light, heat convection, X rays and constitution of the atom.

J. N. Ray, D.Sc., Ph.D. (Vict.), F.I.C., University Chemical Laboratories, Lahore.

Dr. Ray has published nearly 50 papers on synthesis of organic compounds, and on electronic theory of valency.

Pulin Bihari Sarkar, D.Sc. (Paris), Lecturer in Chemistry, Calcutta University.

Dr. Sarkar is the author of about 13 papers on rare elements, analysis, and on organic and inorganic chemistry.

Jitendra Mohan Sen, B.Sc. (Cal), Teacher's Diploma in Education (Oxford); Master of Education (Leeds); Inspector of Schools, Presidency Division, Bengal; President-elect, The Psychological Section, Indian Science Congress, 1936.

Mr. Sen is the author of several books dealing with aspects of primary education, of 6 papers dealing with the application of psychology to education, and of numerous articles on primary and adult education.

R. R. Simpson, M.Sc., C.I.E., Formerly Chief Inspector of Mines, India, at present Chief Mining Engineer Court of Wards, Bengal.

Mr. Simpson is the author of Annual Reports of the Chief Inspector of Mines, 1920-31, *Indian Mines Manual, The Coalfields of India,* and papers on coal and ruby mining, and on accidents in mines.

PIARE LAL SRIVASTAVA, M.A., D.Phil. (Oxon), Reader in Mathematics, University of Allahabad.

Dr. Srivastava is the author of 23 papers principally on analytical functions and series.

A. C. UKIL, Tuberculosis Research Officer, All-India Institute of Hygiene, Calcutta.

Dr. Ukil is the author of about 47 papers on bacteriology, malaria, cholera, tuberculosis, and dysentery.

Honorary Fellows

Under Regulation 2 regarding the election of Honorary Fellows the Council selected the under-noted 10 men of science from among whom the Council at its next meeting may make 8 nominations to the Institute:

LORD RUTHERFORD of Nelson.
PROF. NIELS BOHR, Copenhagen.
PROF. ALBERT EINSTEIN, Princeton University, N.J.
PROF. ARNOLD SOMMERFELD, Munich, Germany.
SIR GUY MARSHALL.
SIR T. H. HOLLAND.
PROF. A. C. SEWARD, Cambridge.
DR. MAX WEBER.
SIR GOWLAND HOPKINS, President of Royal Society.
SIR CHARLES SHERRINGTON, Oxford.

Mr. W. D. West's letter regarding seismographs

The President reported the formation, in the Geological Survey of India, of an earthquake committee, consisting of Dr. A. M. Heron, Mr. W. D. West, and Mr. J. B. Auden, which had drawn up a list of proposed localities for seismographs.

This list was placed before the Council and it was agreed that the Institute should address the Government of India (*a*) recommending that seismographs be installed at the localities given in this list and (*b*) intimating that the Council has formed a sub-committee to advise the Institute on Seismological questions.

The sub-committee appointed consisted of Dr. S. K. Banerji, Dr. M. N. Saha, Dr. N. R. Sen and Mr. W. D. West (Secretary) and it was considered that this sub-committee might subsequently be extended into an Indian National Research Committee for Seismology.

The Academy of Sciences, U. P.

A monthly meeting of the Academy was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad on August 17, 1935. Professor N. R. Dhar, the President of the Academy, was in the chair. The audience was large and contained several distinguished persons as Sir J. C. Weir, Sir Safaat Ahmad Khan and Pandit Iqbal Narayan Gurtu. On that evening a regular symposium was held on the Theory of Relativity.

Sir Shah Muhammad Sulaiman, Chief Justice, Allahabad High Court, opened the discussion. He explained that the existence of gravitons was not at all necessary for his mathematical theory, which was quite distinct and independent of his physical theory. For the former theory the only new assumption which he has made is that the velocity of gravitation was finite. His results were reduced mathematically from this assumption, with the help of Newtonian mechanics. The formulae which he deduced showed that the velocity of gravitation was equal to that of light. Even for the recession of nebulae, gravitons were not necessary, and the emission of radions, *i.e.* light corpuscles, is quite sufficient to explain a gain of acceleration. If, as is supposed in Relativity, the velocity of light was independent of its source, there would be no cross-radial momentum. He answered Mr. D. R. Hamilton's criticism by showing that his physical theory was quite different from Laplace's mathematical theory, which did not yield the three main formulae of Relativity. He quoted Mr. Hamilton's acknowledgement that his theory gave the desired value for the advance of perihelion, and yielded positive values for the increase in the eccentricities of Venus, Earth and Mars. He explained Mr. Hamilton's difficulty about Mercury by showing how the resistance of the medium could produce the negative sign. He pointed out that Mr. Satyendra Ray's suggestion

of absorption of gravitons was not new and had been put forward by Lesage, as modified by Lorentz; and also that a negative D had been used by Laplace. He rejected these, as the results would not tally with observation. As to Professor A. C. Banerji's remarks he pointed out that there were not any disconnected assumptions, but only one new assumption; and that is no cross-radial momentum can be produced if the velocity of light is independent of its source.

He emphasized that although Newtonian absolute velocities were not actually measurable, they were philosophically conceivable and mathematically workable and were definite quantities. But a relative velocity, as distinct from the difference between two Newtonian absolute velocities, had no definite meaning. Its value would depend on the particular method of measurement chosen and would vary as the method changed. He showed several different ways of measuring relative velocities, which would give different results. His formulae based on a double journey method would yield Newton's formulae as a first approximation, and Einstein's formulae as a second approximation. But for higher approximations, it is a function of actual velocities and not only of their difference. He explained that Einstein's formulae were a near approximation, and so gave good results; but it was not rigorously true, and therefore the philosophy based on it was not intelligible to three-dimensional human beings.

He pointed out that many more corrections were necessary in Newtonian Mechanics for greater accuracy in the case of elliptical orbits; he was sure of the effect of retarded gravitation on changes in direction and magnitude of the force, and on longitudinal, transverse and rotational masses. He pointed out how a resisting medium would reduce the perturbations in the elements of the orbits, and said that in some cases the advance of perihelion would remain unaffected by it.

He had predicted that the deflection of light from a star passing the sun would lie between 2″.32 and 2″.45 as against Einstein's value 1″.75. He also claimed that the spectral shift from the centre of the disc of the sun is unreliable as there would be gases moving from the interior radially towards the surface and would reduce the shift. He claimed that the spectral shift of light from the limb of the sun should be .00676 as against Einstein's ·0084. The value as observed by Evershed in 1918 was .006. He has also suggested that the value of the advance of the perihelion of Mercury should be less than what was calculated by Newcomb.

Professor A. C. Banerji who spoke next said that Relativity was a fairly successful attempt in the formulation of a unitary physical theory based on the conception of physical nature being the invariant of transformations. The Relativistic idea of having no absolute velocity was a logical development of our experience. The interconnection of time and space co ordinates was not really a novel idea. In classical hydrodynamics and also in the theory of vibrations they have the interconnections of time and space co ordinates. The particle in relativity traced the path of least resistance which had its classical analogues in optics and mechanics *i.e.* the laws of least path, least time, and least action. The only new idea was that the velocity of light was independent of its source.

In Sir Shah Sulaiman's theory gravitational effect was assumed to be propagated with a finite velocity— a reasonable assumption. In classical electrodynamics also, electromagnetic waves were supposed to travel with finite velocity. It was also legitimate to assume the law of gravitational attraction between two bodies relatively at rest as different from the law of attraction between the same two bodies in relative motion. Some of the other assumptions in Sulaiman's theory were curious combinations of Einstein's and Newton's conception. He assumed that the velocity of gravitation in space was independent of its source. But at the same time he used classical mechanics in calculating the radial momentum taken out by the gravitation, as it emerged from the source and discarded the cross radial momentum taken out by it. The result of that curious process was that the source got self-acceleration without the aid of any impressed forces. It was a strange result.

Then his conceptions of *real* relative velocity and *apparent* relative velocity were far from being simple and were more complex than any conception in relativity. It could be seen from his formulae of composition of velocity that the law of reciprocity breaks down, so his assumptions were more extraordinary and more complex than the assumptions in relativity.

Relativity was not a perfect theory, but nobody could deny that it had achieved a considerable success, specially the special theory, in physics. Sir Shah Muhammad thought that the conception of a mass varying with velocity was an extraordinary assumption. Even before the theory of relativity was propounded the fact that the mass varies with velocity was proved beyond doubt by experiments. The idea about the rotational mass was not in any way simpler than the electrodynamical idea of transverse or longitudinal mass. Professor Banerji did not see till then the necessity of discarding the theory of relativity in favour of another which had got more extraordinary as well as disconnected assumptions giving individual results.

Professor Satyendra Ray of Lucknow University speaking third said that a way of refuting relativity dynamics was to proceed towards absolute motion in space, which he attempted to do in his paper "Graviton and Star-Streaming." Sir Shah Sulaiman objected to negative D as the equal spacing between the gravitons would be disturbed. If we took gravitons falling into a mass and examine the motional field about a graviton we should find that for an observer seated on it it would appear that gravitons in the radial direction, both in front and behind, were being repelled, and those in the tangential direction were being attracted. This agreed with the behaviour of stars in the immediate neighbourhood of the solar system as found by Stroemberg. Again a simple physical explanation might be given of the first power law. Sulaiman had pointed out clearly the existence of approaching as well as receding nebulae, but got from his self-acceleration only positive values of the velocity. If however we assumed all matter to be electrical and ether to possess an electric density, the inverse square law enabled us to determine the force of attraction or repulsion between the solar system and any nebulae. The charges on nebulae might be positive or negative, and both acceleration and repulsion might take place. Regarding criticisms on perturbation in orbits from Sir Sulaiman's theory of Hamilton his equation meant that axial velocity was accelerated. This was against observation.

Professor M. N. Saha speaking fourth said that the special theory of relativity developed by Einstein had rendered a considerable help to the physicists. It gave us the idea of the equivalence of mass and energy and had been considerably used in atomic and nuclear physics. Sulaiman's theory had yet to show its potency in this direction.

Dr. Gorakh Prasad and Mr. Ram Niwas Rai also spoke.

A monthly meeting was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad on August 16, 1935. Professor N. R. Dhar, the President of the Academy, was in the chair.

The Allahabad University has again kindly given a grant of Rs. 500|- to the Academy of Sciences, U. P. for this year. As a mark of appreciation of this help as well as of previous ones, the Council nominated the Vice-Chancellor of the Allahabad University to be a Benefactor of the Academy.

The following papers were read and discussed :

1. N. R. Dhar & S. K. Mukerji : Further experiments on the Fixation of atmospheric Nitrogen in the soil and the utilization of Molasses as a Fertilizer.
2. L. S. Mathur : The Nitrogen atom and the molecule.
3. B. P. Pande : Contributions to the Digenetic Trematodes of the Microcheroptera of Northern India. PART III.--New Distomes the genus Mesodenrium Faust (1919).
4. Satyendra Ray : On Evidences for a Lag Effect in Zeuner's Data on saturated water vapour in Landolt and Bornstein's table.
5. Satyendra Ray : On Evidences of Tidal Waves in an insulated molten interior as obtained in some recent severe earthquakes.

Professor Dhar's experiments show conclusively that the combined nitrogen, specially the most important substances necessary for plant growth, are considerably increased when molasses, the waste product of sugar factories in India, are added to the soil well ploughed. The oxidation of the energy-rich carbohydrates present in molasses causes the fixation of atmospheric nitrogen and this process leads to the increase of ammonium salts and nitrates in the soil.

These researches are of considerable importance both from the point of view of theoretical chemistry and of industrial chemistry.

The paper of Professor Satyendra Ray evoked a lively discussion and a good number of contradictions were pointed out in it by Professor M. N. Saha, who characterized it as fantastic. Mr. Ray contended that the interior of the earth was a molten mass and the position of moon and planets brought about tidal waves in it which gave rise to earthquakes. This hypothesis was alleged to explain the occurrence of the majority of earthquakes near about a new or a full moon.

Indian Physical Society

A meeting of the Indian Physical Society was held on the 21st September, 1935, in the Dept. of Physics, University College of Science, 92, Upper Circular Road, Calcutta.

The following papers were read and discussed :

1. N. K. Saha : Pressure coefficient of Electrical Resistance of Metals.
2. P. Lal & K. Lal : On the Statistical Theory of Neutral Atoms.
3. P. Syam : On the absorbing D layer of the Ionosphere.
4. P. C. Mahanti : Fine structure analysis of Red bands of Magnesium oxide & Isotopic Effect.
5. P. C. Mahanti : Potential Energy curves & the structure of the alkaline earth oxides.
6. H. P. De : State of Polarization of continuous X-rays from a thin Aluminum anticathode.
7. S. Datta & M. Deb : Investigations on the ultra-violet absorption spectrum of Ce^{+++} ion.
8. D. V. Gogate and D. S. Kothari : On the Measurement of quantity of Light by Photoelectric Cell.
9. H. P. De : On the emission of Positrons from Bismuth.
10. K. Prasad and B. N. Ghosh : Studies on Water Jets.

Calcutta Mathematical Society

An ordinary meeting of the Calcutta Mathematical Society was held in the Society's room at 92, Upper Circular Road, *on Sunday the 22nd September, 1935, at 5 p.m.*

The following papers were read :—

(*a*) Dr. P. N. Das-Gupta, M.A., Ph.D.:—" On an Octavic related to two Co-planer Tetrads of Points."

(*b*) Dr. K. Basu, D.Sc. : —" On a new method of Calculation of Stark Effect of any order applicable to Hydrogen like atoms."
(Communicated by Dr. B. S. Ray.)

(*c*) Dr. A. Moessner, Ph.D. :—" Zahlentheoretische Untersuchungen and Resultate."
(Communicated by Dr. B. S. Ray.)

(*d*) Mr. Loo-keng Hua, (Tsing Hua) :—" On Waring's Problem for Cubes."
(Communicated by Dr. B. S. Ray.)

The Geological, Mining and Metallurgical Society of India

The 11th Annual Meeting

The 11th Annual Meeting of the Geological, Mining and Metallurgical Society of India was held in the Presidency College, Calcutta, on the 2nd September, 1935. It appears from the study of the report of the Secretaries that during the year under review (*i.e.* 1934-1935) the activities of the Society have been quite normal and that the increase in the number of exchanges has been maintained. Four issues of the journal of the Society were published during the year and as many as 12 papers found place in them. These were mostly pertaining to Geology, and though one paper on Mining was published none on Metallurgy was received by the Society. It, however, hopes that the mining and metallurgical sections of the journal will show improvement in near future. The financial position of the Society requires an immediate improvement, to effect which the annual subscription rates of ordinary membership have been reduced from Rs. 16 to Rs. 12, with effect from July, 1935.

The following is the Council for 1935-36 :—

President : Professor N. P. Gandhi.

Vice-President : Messrs. P. Evans and J. K. Dholakia.

Joint Secretaries : Mr. N. N. Chatterjee and Professor S. K. Bose.

Treasurer : Mr. S. L. Biswas.

Members of the Council : Prof. M. Chatterjee, Dr. P. K. Ghosh, Messrs. H. M. Lahiri, D. C. Nag, G. G. Narke, B. Rama Rao, K. K. Sen Gupta, and Prof. S. K. Roy.

Calcutta University

The Senate of the Calcutta University at its meeting held on August 14, 1935, abolished the restriction of age for candidates appearing at the Matriculation Examination.

Dr. Friedrich Levi, formerly Extraordinary Professor of Mathematics at the University of Leipzig, was appointed Hardinge Professor of higher Mathematics for a period of five years with effect from the date on which he joined his appointment on a salary of Rs. 1000|- per month.

The term of appointment of Prof. D. R. Bhandarkar, as the Carmichael Professor of Ancient Indian History and Culture, was extended up to May 31, 1936.

Dr. A. J. Barnet Kempers, Reader in the University of Leyden and Conservator, Kern Institute, Leyden, was appointed a Special University Reader to deliver a course of at least two lectures on the "Development of Hindu-Javanese Culture and Art specially in connection with its relations to Indian culture," on an honorarium of Rs. 500|-

Dr. Hemchandra Rai Chaudhuri, was appointed Head of the Department of Ancient Indian History and Culture for two years for the present with effect from 1st. June, 1935.

Sir C. P. Ramaswami Aiyer, Tagore Law Professor for 1932, was requested to deliver his lectures on "Law and Practice relating to Indian States" instead of on "History and Functions of the Supreme Courts" on which he was originally invited to lecture.

The Senate sanctioned the grant of a sum not exceeding Rs. 85,000 for the extension of the buildings of the University College of Science in Upper Circular Road, mainly for the Department of Applied Chemistry, the amount to be met out of the Reserve Fund.

As approved by Acharya Prafulla Chandra Roy, the following grants were sanctioned by the Senate out of the Sir P. C. Ray Fellowship Fund : (i) Rs. 2,000 to Indian Science News Association and (ii) Rs. 5,000 to Prafullachandra College, Bagerhat.

Letters to the Editor

A Common Script For India

By the kindness of the Editors of SCIENCE AND CULTURE who have invited discussion on the problem of a common script for our country, I am emboldened to offer a few remarks for what they are worth on the suggestions put forward in its August 1935 issue. Decision will be reached when all points of view have been expressed and fully weighed with due regard to ease and facilities and I am offering criticisms in the hope that they will be read along with others to arrive at a decision.

The writer of the article has traced the history of writing in Europe and India and opines that writing came into India about 300 B.C. I have not read such history and am not enough to express any opinion. Probably such history is not absolutely necessary at this stage.

But there are suggestions towards the end of the article on which certainly there can be two opinions. It is said that nobody wants to introduce the Roman script as such. Any modified form of it based on phonetic character of Indian languages may be adopted. Then it can be said that some modified form of Devanagri be adopted. These characters are recognized by a vast majority of Hindu literate population of India. There is always some incentive for learning these as the whole religious literature in Sanskrit is in these characters. Consequently this modified proposition will be more readily acceptable to people at large.

Though the writer does not say clearly yet I think he has in mind printing facilities when he makes the suggestion quoted above. I have already referred to the matter in a letter published elsewhere. I need not labour on this point again.

It is further claimed that the student would be relieved of a good deal of useless duplication of labour*. Further it is assumed that the student shall have to read languages using Roman script. On the other hand attempt is being made to impart education to the student through his mother tongue using his own alphabets as the modern practice not only means 'useless duplication' but means a huge waste in every form.

Mother tongue is learnt very early in one's life while students offering Pali in matriculation of Calcutta University tried to learn Pali at a stage when they are familiar (probably more familiar having spent a lot of time and energy) with Roman Script. Whether there was any difficulty in learning the language cannot be decided unless a similar experience of teaching English through Bengali or Devanagri character is tried with those who are in similar circumstances. Probably the number of books prescribed for Examination was small and students always found it easier to learn them specially when there was no test of speech.

One would easily see that the adoption of common script by people claiming origin from the stock both in language and culture would be beneficial. But it is extremely doubtful if a common script will benefit those whose languages are entirely dissimilar. Any Bengali, Gujrati, Marahti or Hindi speaking gentleman will be able to understand something of each of these languages if they are written in the same characters. But if a Hindi or Bengali sentence is put before a European in Roman characters he will find nothing intelligible and familiar except the form.

I have said elsewhere that controversy about Hindi and Urdu is entirely artificial. Do not Mohammedans living in Madras speak Tamil or Telegu as well as their Hindu brethren living with them. They will always find the characters which have been in use for ages more handy as they will find the literature easily available to keep up their interest. It will be another uphill task to reprint literature already available in Roman characters.

An example of Turkey is given where Roman script has been adopted in place of Arabic one in use so far. It may be that Turkey did it easily because when it was foreign it was immaterial whether it was one or the other. It may be that Turkey did it to fall in line with the rest of Europe as it discarded some of its customs as well to be on par with its neighbours in other matters also.

As regards the smallness of the number of alphabets one is tempted to draw attention to capital and small letters and also the difference between letters used in writing and in print. Consequently taking all these points together one sees that the difficulty of learning a large number of alphabets or symbols is not confined to Devanagri alone. It exists elsewhere as well.

Saligram Bhargav.

* Adoption of Roman Script while retaining the phonetic character of Devanagri Script will not avoid duplication, as for purposes of English he will have to pronounce those very symbols differently. To avoid confusion it is much better to have different symbols for different sounds.

Observation on a Disease of Mango at Benares

Mango like so many other important fruit trees of India has been the prey of a large number of diseases both due to insects and fungus. Among the many pests, that happen to affect the plant and the reproductive shoot, the mango hopper and the mildews occupy the foremost

FIG. 1.

FIG. 2

position, and in several cases good deal of damage has been reported to be caused by these formidable pathogens[1]. The disease to which a reference is going to be made the present paper is an altogether different one.

It was in the month of June 1933 that the author's attention was drawn to certain mango trees bearing inflorescence along with the well developed fruits (Fig 1). The occurrence of such abnormal inflorescences being limited, their inportance was not felt to any well marked extent in 1933 but the recurrence of the same phenomenon next year and its abundance in the current one led us to set an enquiry, the preliminaries of which are given below.

Symptoms: The main symptom of the disease is the production of abnormal inflorescences on trees along with the normal ones in the flowering season. There is practically no difference between these two types of reproductive shoots but with the progress of time the growth of the normal inflorescence gets arrested after fertilization and development of fruits while the abnormal ones continue

Fig. 3.

to grow slowly and do not bear. They grow in abundance up to the advent of intense heat waves in the month of June when a majority of them dry up and fall and only a few continue to grow up to the next flowering season. During rains most of these flowers rot and assume a black colour. They have been found to be chiefly confined to the young trees and also to the ones which are fruiting in the season. They are rarely found on trees which fail to flower.

As to the morphology of the individual flowers there is very little difference, but the inflorescence differs widely from the normal ones. The flowers here are found to be arranged more compactly along the axis (Fig. 2, 1-4). They also bear scale leaves (fig. 2, 5-9). Inflorescences have been found with flowers or with scale leaves or with both intermixed. According to the length of the main axis and secondary branches, the inflorescences can also be divided into two groups (a) compact (fig. 2, 3, 4, 7, 8 and 9) and (b) Semi compact (Fig. 2, 1, 2, 5, 6) but it may be noticed that even in the latter case where the flowers or scales occur at the apex of the branches they are set as compactly as in the former one. The flowers are all sterile.

The disease has been found to recur on the same plant throughout the three consecutive years of observation. In the present year a certain number of trees free from the disease have been marked in order to study its spread to the new plants

Extent of damage: An estimate made on a large number of trees within the University compound indicated that the percentage of affected trees is nearly twenty two Of the total fruiting spurs on the different individuals the proportion of those converted into abnormal inflorescences was found to vary from 0.1 to 100 per cent (fig. 3) with an average of 6 7 per cent. Occurrence of cent per cent infection was found to be confined to the very young trees.

Apart from the morphological interest, the development of such abnormal inflorescences has got a profound bearing on the economic side If a proportion of the fruiting spurs remains unproductive there is a definite loss to the orchardist. Excepting on certain young trees the outbreak of the disease has not been so serious as to call an immediate attention but if it spreads to new trees and increases in intensity it may endanger the plantation of this important fruit tree in the localities near about Benares.

Further investigations are in progress.

Institute of Agricultural Research, Benares Hindu University.

B. N. Singh.
S. C. Chakravarti.

Explanatory notes for figures

Fig. 1. A mango tree bearing abnormal inflorescence along with developed fruits.

Fig. 2. The abnormal inflorescence of Mango. 1-4 with flowers; 5-9 with scale leaves, 1, 2, 5, 6 semi-compact; 3, 4, 7, 8, 9, compact.

Fig. 3. A mango tree where all the fruiting spurs have been converted into abnormal inflorescences.

1. Rao, Ramchandra Y., The mango hopper problem in South India. *Agri. Journ. India.*, **25**, 17, 1930.

Wagle, P. V., ***Studies in the shedding of mango flower and fruits*** Part I, *15* No. 8, 1928.

Incidence of dermal leishmanoid and its Probable Aetiology

The term dermal leishmanoid was first used by Sir U. N. Brahmachari for a peculiar type of skin eruptions discovered by him in 1922 in certain patients who had recovered from Kala-azar. Since then, much work has been done on the subject. The tendency of replacing the above name by dermal leishmaniasis is unfortunate, as cutaneous leishmaniasis or tropical sore, is no doubt also a form of dermal leishamaniasis. I suggest that the term leishmano-derma may be used for the condition.

Up to now it has been assumed that dermal leishmanoid is a manifestation of immunity of the internal organs to infection with leishmania donovani, acquired either after an attack of Kala-azar or more rarely in persons, living in endemic areas of kala-azar, in whom there has been no previous clinical history of the disease.

One remarkable fact that has to be noted about dermal leishmanoid is that it does not occur outside India. I am indebted to Sir U. N. Brahmachari for giving me the following information on this point from personal communications received by him from observers in various parts of the world outside India, where kala-azar occurs:

The librarian of the Royal Society of Medicine has given a note that after a careful search for cases of dermal leishmanoid or post-kala-azar dermal leishmaniasis occurring in places outside India, he was unable to find any.

Professor Enrico Emilio Franco of the University of Bari, Italy, has written to say that he has never seen a case of dermal leishmanoid.

Dr. M. Khalil Bey, Professor of Parasitology, Egyptian University, Cairo, has stated that he met with a case resembling the disease in a district in Egypt. But he further stated that while there was a great incidence of oriental sore in the locality, no positive proof of the existence of visceral leishmaniasis was available there. It therefore appears that the case noted by him might be one of non-ulcerating oriental sore resembling dermal leishmanoid.

Dr. M. D'Oelsnitz, from Nice (France) stated that he never found any case of dermal leishmanoid in infantile kala-azar in his experience.

Dr. H. J. Smyly, Cheeloo University, Tsinan, Shantung, China, has written to say that so far he has not met with a single case of dermal leishmanoid in China.

Dr. C. U. Lee, Department of Medicine, Peiping Union Medical College, Peiping, China, has not met with any case of dermal leishmanoid in Peiping or elsewhere in China where kala-azar is prevalent.

From the above it is concluded that no undoubted case of dermal leishmanoid has been observed outside India and it may be argued that there are two kinds of leishmania donovani, one which gives rise to kala-azar without such sequelae as manifested by dermal leishmanoid and another to kala-azar which may subsequently be followed by it. If this view is correct, then it may be possible to discover in future the different features of the two strains of leishmania donovani, but at present the idea is purely speculative. The fact that in practice one meets with cases of kala-azar which may remarkably vary in their response to antimony treatment also lends support to the view that there may be different strains of leishmania donovani in existence. In India perhaps both the strains exist.

Brahmachari Research Institute,
82/3, Cornwallis Street, Calcutta.
Phanindranath Brahmachari.
19.8.35.

A Polyembryonic Grain of Paddy *(Oryza Sativa)*

While examining the germination of the F_2 progeny of a cross between Type 782/34 X Type 401/34 a solitary grain was found sprouting with two plumules. Careful examination of the specimen revealed that not only the two shoots were

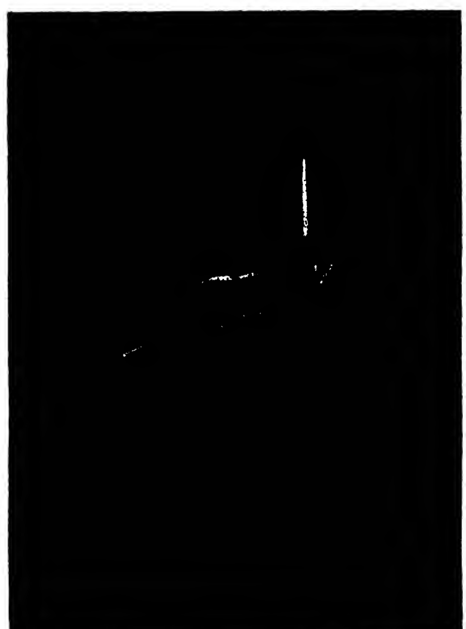


Fig. 1

from the same grain, but there were also two distinct primary root systems. The distinct and separate nature of the plumules and their root systems naturally suggest that this is a clear

case of a double embryo in a single grain of paddy. (To be distinguished from the so-called 'Double Rice' where the number of ovaries in the flower is three, and gives rise to 2 to 3 grains inside the husk).

Such cases of polyembryonic grains in paddy are very rare and only few cases are on record. H. Kumoro[2] in Japan was the first to record this in paddy. He found a single grain which produced two plants, which were identical in nature. In October at the time of harvest there were in all 22 tillers in the two plants taken together. Ordinarily in this variety (Sekisan) the average number of tillers is 10. Kumoro [2] germinated all the seeds from these two plants but none of them were polyembryonic as before. Rodrigo[5] made the problem very complicated. It would, therefore, be better to wait till more confirmatory information vouched by embryological and genetical studies is available on the subject.

Ramiah and others [4] have shown that the pure line T 24 and its hybrid progeny consistently show this polyembryonal behaviour in proportion of 1 in 1000 seeds. They regard this phenomenon as a heritable character in rice. Its occurrence in a cross (Type 782/34 X Type 401/34) suggests that a slightly disturbed condition in the plant may be responsible for such a behaviour. I think it would be safe at this stage to regard it as one of the various kinds of abnormalities met with in nature.

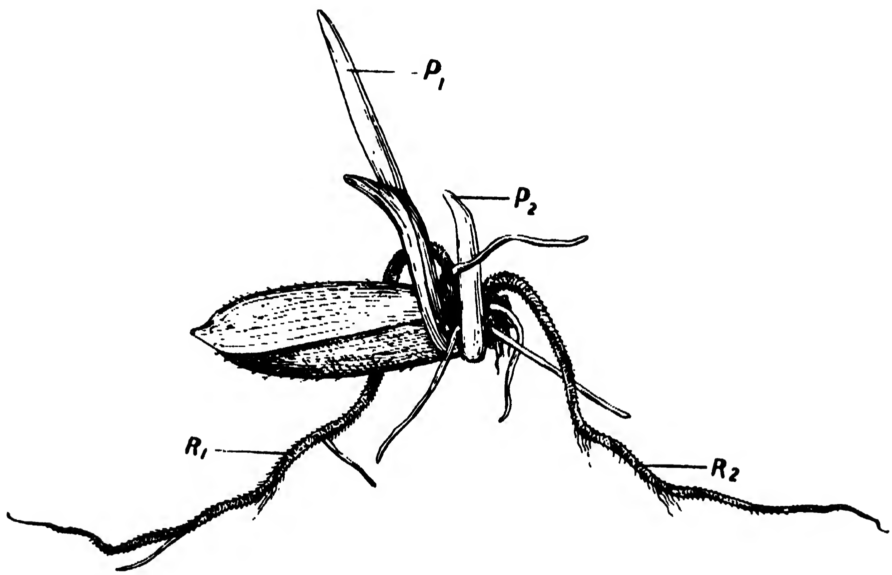


FIG. 2

in the Philippines also found a grain of a rice variety like that of Kumoro [2] and later germinating about 107,000 seeds of this variety got only one seed with two plumules. Later, Jones [1] in America obtained a polyembryonic grain from a cross between two varieties of rice. The twins resulting therefrom were of hybrid nature and according to him, arose from one fertilized egg.

In India, Ramiah, Parthasarathy and Ramanujam[4] are the first to record such cases in a pure line T 24 and in several hybrid progenies. In their recent publication they have studied some very interesting cases of twins and even triplets in paddy.

From the literature, it appears that the origin of polyembryony in Paddy may occur in various ways. In some cases, however, the occurrence of a double embryo-sac as suggested by Ramiah and others [4] is a very plausible one.

But the occurrence of a normal diploid individual in association with a haploid one (Ramiah and others [3]) has

The photograph of the actual specimen is prepared through the courtesy of Dr. H. N. Roy of the Zoology Dept., Calcutta University.

Rice Research Station, Chinsurah. Eric Amullya Ratan Banerji.
15.8.35.

1. *Journ. Amer. Soc. Agron.*, **20**, 533, 1928.
2. *Bot. Mag. Tokyo.*, **36**, 23, 1922.
3. *Cur. Sci.*, **1**, 277, 1933.
4. *Ind. Journ. Agric. Sc.*, **2**, 119, 1935.
5. *Philip. Agric.*, **14**, 629, 1925.

On Algae found in Soil Samples from an Alluvial Paddy Field of Faridpur, Bengal

An investigation of algae found in alluvial soil samples from a paddy field of Faridpur, Bengal, has been in progress in this laboratory for some time at the instance of the Imperial Council of Agricultural Research. The samples, which were collected by professor J. C Ghosh of the Dacca University, consisted of two tubes, one containing a few grams of sifted and air-dried soil and the other a few cubic centimetres of muddy water from the same source after it has been water-logged for some time.

A series of cultures, with Bristol's[1] original and diluted aqueous mineral salt solutions, were set up on 19.12.34 in wide-mouthed bottles and petri-dishes filled up to a depth of about half an inch with burnt sand or sterile, sifted garden soil. The bottles were then tilted on one side to provide both moist substratum and free water surface for the algae to grow upon. The series was then divided into two sets, one was inoculated with the soil and the other with the muddy water sample. The substratum of each of the petri-dishes was then covered with a piece of chemically pure, sterile filter-paper which was kept in close contact with it. The entire operation was performed under a complete aseptic condition.

First set: The liquid media of few culture-bottles turned greenish at the end of about four weeks while on microscopic examination, single and dividing cells of *Protococcus viridis* Ag. were observed. Very small, isolated, young filaments of *Phormidium luridum* Gom. appeared on the surface of the liquid media of the bottles and on the filter-papers of the petri-dishes after the lapse of nearly three weeks more. They eventually formed patches and covered the whole available spaces. Gelatinous, brown patches, composed of juvenile forms of *Nostoc commune* Vaucher, were observed with unaided eyes on the surface of the substratum of a few cultures about a couple of months later. *Tolypothrix campylonemoides* Ghose appeared about a year after.

Second set: Cells of *Protococcus viridis* and filaments of *Phormidium luridum* could, at first, be traced by the middle of February. Subsequently, juvenile forms of *Nostoc commune* Vaucher *Phormidium valderianum* (Delp) Gom., *Phormidium corium* Gom, *Nostoc* sp. (?), *Calothrix Braunii* Bornet et Flah., and *Fischerella muscicola* (Thuret) Gom. appeared on the substratum and on the sides of most of the culture-bottles and also on the upper surface of the filter-papers of a few petri-dish cultures. The developmental stages of some of the forms continued for such a long time that it was not possible to identify them with any degree of certainty until quite recently when such stages were over. The specific name of a *Nostoc* could not at present be added owing to its difference from the known forms.

It has been possible to isolate all the nine species of algae in pure forms and out of these only six could

Fig. 1

be successfully grown in agar medium containing dilute mineral salts. The remaining three, *Calothrix Braunii*, *Phormidium valderianum* and *Fischerella muscicola*, produced very small patches and there had been no further development. Figure 1 shows seven of the pure forms on agar medium in tubes. The cultures were set up on 6. 10. 34 and photographed on 9. 3. 35.

Tube 1. *Nostoc commune* Vaucher.
" 2. *Phormidium luridum* Gom.
" 3. *Phormidium corium* Gom.
" 4. *Protococcus viridis* Ag.
" 5. *Nostoc* sp (?).
" 6. *Fischerella muscicola* (Thuret) Gom.
" 7. *Tolypothrix campylonemoides* Ghose

Figure 2 shows the nature of growth and development of *Phormidium corium* on agar medium which was inoculated on 12. 1. 34 and photographed on 6. 7. 34.

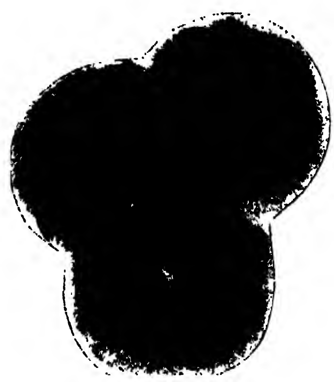


Fig. 2

The soil under investigation is particularly rich in blue-green algae associated with a large number of bacteria

and there is complete absence of diatoms. Kossowitsch[2] definitely proved in a few of his cultures that nitrogen fixation was the result of bacterial activity and concluded that there exists a symbiotic relationship between the algae and bacteria of the soil. Mucus investment of Myxophyceae possibly plays an important part in helping the soil to retain moisture.

Detailed results of my observations on be ublished elsewhere.

I wish to acknowledge my indebtedness to Prof. S. P. Agharkar and Prof. Fremy of Paris for their valuable suggestions and to Dr. H. N. Roy and Mr. D. Mukherji for their generous help.

Department of Botany, Calcutta University, 35, Ballygunge Circular Road, Calcutta. Jogendra Chandra Banerji.

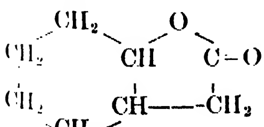
3. 8. 35.

1. Bristol, B. M.—On the Alga flora of some desiccated English soil: an important factor in soil Biology. *Ann. Bot.* *34.* 35.-80, 1920.

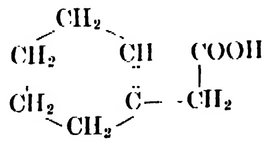
2 Kossowitsch. P.—Untersuchungen über die Frage, ob die Algen frien stickstoff fixiren.—*Bot. Zeit.*, Heft. 5., pp 98-116, 1894.

Certain Intermediates for the Synthesis of Phenanthrene

Friedel Crafts' reaction with aliphatic unsaturated acids and lactones, and aromatic hydrocarbons has been studied by Eijkmann[1], and a few phenyl and substituted phenyl derivatives of aliphatic acids have been obtained. Very few Friedel Crafts' reactions, however, with cyclic unsaturated acids and bicyclic lactones have been studied up to this time and among them may be mentioned the reaction of phthalides with aromatic compounds. The present work was undertaken with a view to study his reaction with saturated bicyclic lactones of the type of Hexahydro α-coumaranone (I) and unsaturated acids of the type of $\Delta^{1,2}$ cyclohexenacetic acid (II)



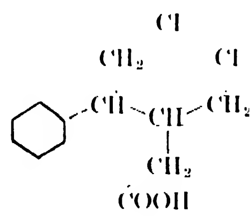
(I)



(II)

The main object of the present work, however, is to synthesize phenanthrene derivatives by the condensation of cyclohexano-lactone (hexahydro-α-coumaranone) and its derivatives with aromatic bodies. A new synthesis of Hexahydro-α coumaranone has been achieved by the present author in the following way. Ethyl cyclohexanone-2-carboxylate was converted to diethyl cyclohexanone-2- acetic -2- carboxylate (Bp. 161-162°/5 mm) by its interaction with ethyl chloracetate in presence of sodium. Cyclohexanone-2-acetic acid (Bp. 167-170°/7 mm, Ethyl ester Bp 130°/10 mm; Semicarbazone of the acid M. P. 200°C; semicarbazone of the ester M. P. 196°) obtained by the hydrolysis of the above ester was reduced by means of sodium amalgam and then heated with dilute sulphuric acid when the lactone hexahydro-α coumaranone (I) (Bp. 137°/15 mm 130°/10 mm.) was obtained in satisfactory yield.

The lactone (I) was then condensed with benzene in presence of aluminium chloride and the product was purified by distillation in vacuum (Bp. 195—200°C/8 mm.; M. P. 69—70°C acid chloride Bp. 168—171°C/7 mm.; amide M. P. 196 197°C). The acid (II) was then condensed with benzene in presence of aluminium chloride and purified by vacuum distillation. The fraction boiling at 195 200°C/8 mm. solidifies and melts at 68—70°C. Acid chloride Bp. 168—171°C/7 mm.; amide M. P. 196—197°C. Mixed melting point of the amide from the condensation of (II) and benzene and the amide from the condensation of (I) and benzene is not altered (M P. 196 197°C). The acid is therefore III



(III)

Further study regarding the constitution of the acid and its conversion into phenanthrene is in progress. The details of the above work will be published in the *Journal of the Indian Chemical Society*.

My sincere thanks are due to Sir P. C. Ray for his kind interest in this investigation.

Sir T. N. Palit Laboratories, University College of Science, Ranajit Ghose.

9. 9. 35.

1. *Zentralblatt*, *1*, 1416, 1904; *1*, 1388, 1905; *2*, 2045, 1907.

A Crystalline Bitter-principle from Andrographis Paniculata

A crystalline bitter was isolated and studied by Gorter[1] who prepared the tri-acetyl derivative and proved the presence of two double bonds in the molecule and gave it the formula $C_{20}H_{32}O_4$. Bhaduri[2] described in scanty detail the isolation of two principles with the formulae $C_{19}H_{28}O_5$ and $C_{18}H_{21}O_5$ (?) respectively. In the present work, the bitter has been obtained in a pure form, m. p. 220°C (decomp.). The formula ascribed to it is $C_{20}H_{30}O_4$ which is very close to that of Gorter. Our bitter, however, does not acetylate under ordinary conditions and contains only one double-bond (as determined by catalytic hydrogenation and a study of its additive reactions). It combines with HCl and ICl quantitatively. The presence of a lactone ring has been established by gentle hydrolysis with caustic alkalis or baryta, and two crystalline isomeric hydroxy-acids have been isolated m. p. 156° and 180° C respectively, which may be reconverted into the original lactone. From analysis of the crystalline barium salts of these two, the molecular weight of the bitter has been deduced to be about 350 agreeing closely to the formula $C_{20}H_{30}O_5$, and this idea has been further confirmed by analyses of the other derivatives of it. The bitter easily undergoes dehydration into a yellow resin at a little above its m.p. and at a higher temperature loses CO_2 being converted into a brownish gum which dissolves in organic solvents with a yellow colour with a strong green fluorescence. The bitter dissolves in $POCl_3$ and reacts with PhNCO to give definite derivatives; these reactions together with its easy dehydration are taken to indicate the presence of a OH group. It gives a rotation $[\alpha]_D$ of—123°·5 in acetic acid. Its reactions with zinc dust and with sodalime, its selenium dehydrogenation, and its potash-fusion will be described elsewhere. The presence of methoxyl-, ethoxyl-, aldehyde or ketone group is not detectable, but a methylene-dioxy-group has been proved to be present. The work is being continued.

Chemical Laboratory, S. S. Guha Sircar.
Dacca University, Ramna. A. Moktadar.

1. *Rec. trav. chim.* *33*, 239, 1914; *30*, 151, 1911.
2. *Amer. J. Pharm.* *86*, 349, 1914.

Latent Heat of Condensation of Metals

It is well known that the electron-gas theory of metals has met with notable success in explaining some of the properties of metals like the contribution to paramagnetism due to orientation of the electron-spin, density and compressibility, electrical and thermal conduction and so on. In the present note attempt is made to extend the same hypothesis to the calculation of latent heat of fusion of metals.

Consider a system of isolated atoms forming the vapour of a metal. If now by a process of adiabatic cooling, condensation to the liquid or to the solid state is brought about, there is a decrease in the total energy of the system equal to the latent heat of condensation of the states concerned. Condensation may be supposed to be due to an alteration in the cohesive forces between the electron and the ion on account of which a gradual transformation takes place from the motion of the valence electrons in individual atoms of the metal-vapour to the motion of the free electrons in the solid metal. Since the thermal energy of the *ions* is relatively small, there will be consequently a decrease in the total energy of the free electrons corresponding to the energy decrease of the system by condensation. Further from the general theorem of virial it follows that this would involve a corresponding increase in the average kinetic energy of the free electrons equal to the latent heat of condensation of the system.

The average kinetic energy per electron of the degenerate electron-gas at absolute zero is given by

$$E = \frac{3}{5} E_0 ; \qquad E_0 = \frac{h^2}{2m}\left(\frac{3n}{8\pi}\right)^{\frac{2}{3}} \qquad \dots (1)$$

where E_0 is the null-point energy of the electrons, n being the number of electrons per unit volume. The total kinetic energy of the electron gas in a volume V containing N electrons is therefore

$$E = N\bar{E} = a n^{\frac{2}{3}}, \quad a = \frac{3}{10}\frac{h^2}{m}\left(\frac{3}{8\pi}\right)^{\frac{2}{3}} N \quad \dots (2)$$

Now from the virial theorem applied to an assembly of particles subject to inverse square forces, we have

$$\Delta\,(\text{Kinetic energy}) + \Delta\,(\text{Total energy}) = 0 \qquad \dots (3)$$

Applying (3) in conjunction with (2) to the fusion of a solid metal at constant temperature, the increase in total energy of the electron-gas on fusion, or the latent heat of fusion of the metal becomes

$$L = -\Delta E = -\frac{2}{3} a n^{-\frac{1}{3}}.\,\Delta n$$
$$-\frac{2}{3}\bar{E}N.\,\frac{\Delta V}{V} \qquad \dots \quad \dots \quad (4)$$

with the help of the relation $n = N/V$. We notice that there will be no change in the kinetic energy of the ions as they obey the classical statistics where the kinetic energy is a function only of the temperature. L is the latent heat of fusion per gm-atom of the metal, N is the Avagadro number and $\Delta V/V$ is the relative change in volume on fusion.

From (1) we have

$$\bar{E} = \frac{3}{10}\frac{h^2}{m}\left(\frac{3n}{8\pi}\right)^{\frac{2}{3}}; \qquad n = \frac{\rho z}{A m_{\mathrm{H}}} \quad \ldots \quad (5)$$

where ρ = density, A = atomic weight, m_{H} = mass of the hydrogen atom, and z = the number of free electrons per atom. On substituting the numerical values of the constants we get

$$\bar{E} = 15{\cdot}54\left(\frac{\rho}{A}\right)^{\frac{2}{3}} z^{\frac{2}{3}} \text{ electron-volts} \quad \ldots \quad (6)$$

Hence from (4)

$$L = 0{\cdot}64\ \bar{E}\left(\frac{\Delta V}{V}\cdot 100\right)\text{Kilojoules} \quad \ldots \quad (7)$$

Thus from the density, atomic weight and relative change in volume on fusion, the latent heat of fusion of the metal can be calculated.

The results of such calculations for a number of metals are shown in the following table.

Element	Atomic weight	Density of molten metal at m.p.	E electron volts	$100\frac{\Delta V}{V_s}$	L (cal.) Kilojoules per gm-atom	L (obs.) Kilojoules per gm-atom
3 Li	6·940	0·534	2·81	1·5	2·70	3·
11 Na	22·907	0·93	1·83	2·5±0·1	2·93	2.63
19 K	39·096	0·83	1·19	2·5±0·3	1·9	2.40
37 Rb	85·44	1·475	1·04	2·5±0·2	1·7	2.18
55 Cs	132·81	1·84	0·90	2·5±0 2	1·43	2.09
47 Ag	107·88	9·4	3·05	4·5±0·5	8·8	11.7
29 Cu	63·57	8·3	4·0	4·1±0·1	10·5	11.1
79 Au	197·2	19·3 (solid)	3·31	5·2	10·9	13.1
80 Hg	200·61	13·692	2·59	5·15	8·65 ?	2.34
48 Cd	112·41	8·64 („)	2·9	4·7±0·1	8·7	5.21
30 Zn	65·38	7·1	3·54	6·5±0·5	14·72	6.97

The average kinetic energy E has been calculated from (6). The values of $\Delta V/V$ are taken from experiment. The values of L calculated from (7) are shown in the last but one column, and the experimental values in the last column. It will be seen that in every case the result calculated is of the right order of magnitude, and that the numerical agreement may be considered to be on the whole satisfactory in view of the extremely simplified model of metal used. Only the case of Hg seems to be abnormal.

Allahabad,
15.8.35

D. S. Kothari.
N. K. Saha.

Structure of Benzil

Benzil belongs to the trigonal trapezohedral class of crystals. Allen[1] from some ionization spectrometer measurements concluded that the lattice is hexagonal as the spacings calculated according to the hexagonal lattice had much less abnormal spacings than those calculated from the rhombohedral lattice. To decide the point more rigorously, we took rotation photographs about the hexagonal axis and one diad axis. The number of molecules per unit cell was found to be 3. The odd value shows definitely that the basic lattice is hexagonal. To determine the spacegroup we have next to see whether the lattice points lie along the diad axes or along planes normal to the diad axes. The diad axes have been found by Des Cloiseaux[2] to be the bisector of the m faces developed on the crystal. This result which was confirmed by Allen from X-ray measurements was again checked by us by fresh goniometric measurements. Rotation photographs along a diad axis gave a spacing $1/\sqrt{3}$ times that along the normal to a diad axis and the Triad axis shows that the diad axis is also the cell axis. Thus the spacegroups for the two enantiomorphic forms come out to be D c 31 and D c $\bar{3}$ 1.

Intensities of reflections from some of the planes have been measured by a Zeiss photometer. By trial and error method it is found that the benzyl molecule has its two benzene rings in two parallel planes in a manner similar to the structure proposed by Robertson for the dibenzyl molecule. A more thorough investigation about this group is in progress. The authors have great pleasure in thanking Prof. S. N. Bose for his interest in the work.

K. Banerjee.
K. L. Sinha.

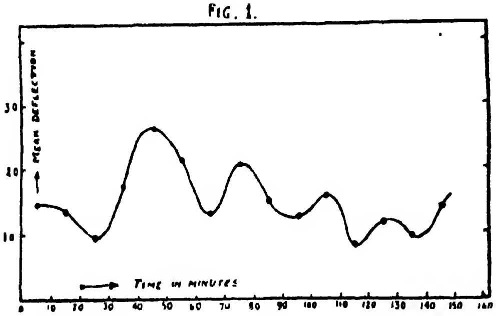
1. *Phil. Mag.* 3, 1037, 1927.
2. Groth's *Chemische Kristallographie*, 5, p. 200.

Beat-Phenomenon in the "fading" of Wireless Signals

The causes of "fading" of signal intensities at a distant station are well known. Radio-waves of appreciable intensity may be returned at night, which interfere with the direct or ground wave travelling from the transmitter to the receiver. Such atmospheric waves may have suffered one or more reflections at the reflecting layer and at the surface of the earth which can be considered a perfect conductor for wavelengths within the broadcast band. When the distance between the transmitter and the receiver is moderate the fading is mainly due to the interference of

the atmospheric wave and the ground wave. For long distances, however, interference may take place between the different atmospheric waves arriving at the receiver by slightly different paths. The variation of signal intensity is due to the varying intensity and phase of the downcoming waves. If the reflection coefficient of the ionized layer is taken to be more or less constant the fading phenomenon is primarily due to the varying phase of the atmospheric wave. As the height of the reflecting layer, its electron-density etc., are constantly varying, the phase of the downcoming wave reflected from the ionized layer should also vary between wide limits. Appleton & Barnett's original experiments[1] show that for a distance of about 50 miles between the transmitter and the receiver, where the intensity of the ground wave is very much stronger than the downcoming wave, the average night-time valne of the

FIG. 1.



signal intensities is equal to the day-time value which is practically constant. This signifies that the phase of the atmospheric wave varies at random,—the phase-difference between the ground wave and the atmospheric wave lying between 0 and 2π.

With such random phase-differences it is expected that the mean intensity of fading over a large interval of time would be more or less constant. From our 1/2 min. observations of the intensities of fading of the V.U C. signals (Calcutta), galvanometer deflections were averaged over 10 minutes. These average values of signal intensity for every 10 minutes successively, altogether covering a period of 2 hours and 37 minutes, when plotted against time showed characteristics similar to the phenomenon of beats. This is shown in fig. 1. The amplitude gradually diminishes and then again it tends to increase. Other sets of observations with the same station for shorter intervals of time seem to reveal the same feature. The fading of Nankin signals however shows this feature to a much lesser extent.

The results strongly suggest the presence of two waves of nearly equal wavelengths. It is not considered likely that the transmitting station which sends a wave-band is the cause of this beat-effect. In that case the mean galvanometer deflections due to the day-signals would also show this effect. The day-signal intensity is, however, more or less a constant quantity. The possibility of a change of wave length on reflection at the ionized layer is also very remote. The effect can perhaps be attributed to a component of the earth's magnetic field modifying very slightly the wavelength of the atmospheric wave.

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12.8.1935.

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Bimalendu Sen Gupta.

1. *Proc. Roy. Soc. A*, *109*, 1925.

Symbols on the punch-marked coins of Ancient India

Mr. Durga Prasad's *Classification and Significance of the Symbols on the Silver Punch-marked coins of Ancient India* has been published in the *Journal and Proceedings of the Asiatic Society of Bengal*, N. S. Vol. *XXX*, 1934, No. 3, Numismatic Supplement. One may not agree to all that the author has said; for example, his utilizing the Tantric texts for the interpretation of the Coin-Symbols is, to say the least, unconvincing. But here we confine our remarks to one interesting finding of Mr. Durga Prasad. The author shows that some symbols are really as old as the era of the Indus Civilization, inasmuch as they occur in the same or slightly modified forms on the Mohenjo-daro seals. The same fact has been pointed out synchronously by Dr. C. L. Fabri in the *Journal of the Royal Asiatic Society*, April, 1935. It is difficult to determine what these symbols signified at the time of the issue of the punch-marked coins; it is more likely that they were used merely as mint-marks or as decorations (as Greek on the coins of the later Western Satraps), than that they conveyed the same meaning as when they had been used as pictographs on the Mohenjo-daro seals. But they definitely prove the diffusion of the Proto-Indian Culture, the traditions of which must have lingered *in the heart of India* till comparatively recent times when the punch-marked coins were minted.

Allahabad.
10.9.35.

A. Ghosh.

Supplement

Symposium on Ionosphere

National Institute of Sciences

[Held on the 23rd August in the Hall of the Asiatic Society of Bengal under the auspices of the National Institute of Sciences, India. It was reported in the last issue of the SCIENCE AND CULTURE *that a Symposium on Ionosphere was organized by the National Institute of Sciences, on the 23rd August along with the second general meeting of the Institute. Since our September issue was almost ready it was not possible for us to publish the summary earlier.- Ed.]*

Sir L. L. Fermor, F.R.S., the Director of Geological Survey of India and the President of the National Institute of Sciences, presided at the function. In declaring the symposium open Sir L. L. Fermor remarked that 'Symposium' meant drinking together and, in this case, from the Cup of Knowledge. He therefore requested the participants to describe the subject as far as possible in such language that the other fellows and guests could easily follow the discussion.

Professor S. K. Mitra

Professor S. K. Mitra, Ghose Professor of Physics, Calcutta University, opened the symposium. He gave a very interesting review of the state of the atmosphere above us and exhibited a large number of slides as well as a cinematograph film of the cathode ray oscillograph records of the reflected echoes. His review is summarized below. Said Prof. Mitra :—the atmosphere up to a height of about 10 kms. where constant changes in the atmosphere are taking place, is known as the *troposphere,* over this is the transitional region known as the *tropopause* after which we have the *stratosphere,* where the temperature of the atmosphere is found more or less steady and is about 80 degrees below the ice temperature. Above the stratosphere is the *ozonosphere* at the height of about 30 km. This is the region where a considerable amount of ozone is present which is responsible for the cutting out of the ultra-violet part of the solar radiation. Near about this region is an ionized D-region, a direct proof of which has recently been obtained by the researches carried out at Calcutta.

From about 100 kms. above the earth's surface is a height extending beyond 300 kms. the atmosphere is strongly ionized and is stratified into a number of layers. The whole of this region is known as the Ionosphere. The existence of electrical conductivity in the upper atmosphere was first proposed by Balfour Stewart in 1878 to explain diurnal variation of terrestrial magnetic intensity, and in 1902 Kennelly and Heaviside postulated the existence of upper atmospheric ionization to explain long distance wireless wave propagation. But it was almost a quarter of a century later that in 1925 Appleton proved experimentally the existence of such ionized regions at a height of about 90 Kilometers. This layer is now well known as the *Kennelly-Heaviside layer.* After this direct evidence the progress in the study of the state of the upper ionized atmosphere has been very rapid, and now it has been proved that in addition to the Kennelly-Heaviside layer there is one more permanent layer at a height of about 250 kms. which is known as the F-layer and is also called after its discoverer *the Appleton layer.*

In addition to these two permanently ionized regions two other layers, the E_2 (height 150 kms.) and the F_1 (height 180-200 kms.), have also been found to exist during the day time.

A simple theory of the mode of propagation of wireless waves in medium containing charged particles, first suggested by Eccles in 1912, was developed by Larmor in 1924. The theory was elaborated by Appleton, Goldstein and others by taking into account the effect of the earth's magnetic field on the motion of electrons and ions. This theory is known as the magneto-ionic theory of the Ionosphere. It follows from this theory that a radio wave packet sent upwards into the ionosphere is split up into two components in different states of polarization. If the two component waves enter regions of gradually increasing ionization then they may give rise to three reflected echoes, one of the two component waves being reflected from two different ionic densities. Conditions are, however, usually favourable for the observation of only two component echoes, the first being a right-handed and the second a left-handed component in the northern hemisphere. The third component echo is almost always missing but is reported to have been observed at Allahabad by Mr. G. R. Toshniwal and his coworkers.

Out of the various methods so far used by the scientists for the study of the upper atmosphere the most fruitful one has been the radio method known as the pulse or group retardation method first employed by Breit and Tuve and subsequently developed by various other workers. Briefly speaking, the method consists in sending up wave packets of short duration from a radio transmitter. These waves return after a few milli-seconds being reflected from the ionosphere. Study of these echoes has given us considerable information regarding the ionosphere.

Using this method it has been found that at Calcutta the number of electrons per cubic centimeter during summer noon for the Kennelly-Heaviside region E_1 (height 90 kms.) is 7.3×10^5, for E_2 (height 150 km.) the number is 11×10^5, for F_1 (height 180 km.) the number is 13×10^5 and for F_2 (height 250 km) the number is 20×10^5 electrons per cubic centimeter. These numbers are much higher than those obtained in higher latitudes. This is in accordance with the view that ionization is caused by the rays of the sun.

It has also been shown that the lower boundary of the E_1 region is extremely sharp and the corresponding boundary for the main F region is very diffuse.

By observing the penetrating frequencies for the two magneto-ionic doublets it has been possible to find out the value of the earth's magnetic field at heights of about 250 km., a task impossible for a geophysicist.

It is possible, by means of the pulse method, to determine the number of collisions per second of electrons and ions with neutral atoms and molecules at ionosphere levels. Recently, another method has been developed for estimating the collisional frequency. This is known as the method of interaction of radio waves. It is sometimes found that when a receiver is tuned to receive a station on a particular wavelength the speech or music of another station working on a different wavelength is heard on the background. This phenomenon is also known as *the Luxembourg effect*. This effect was so called because Tellegen, listening in Holland to the signals of the Baromunster B. C. station in Switzerland found that the programme of the Luxembourg station could be heard faintly in the background. This could not be due to nearness of the wavelength as these were widely different. The origin of this cross modulation is traced to the collision of electrons with neutral atoms and molecules in the inosphere. In the lower region the collisional frequency is found to be about 10^6 per sec.

From experimental evidence obtained by Appleton it seems that there is a possibility of the existence of molecular temperatures as high as 1200° Absolute. —a temperature at which many metals easily melt.

It seems almost definite now that the solar light is the chief agent for ionizing the upper atmosphere. According to Milne, neutral particles shot off from the sun may also be one of the ionizing agencies. Experiments made during solar eclipse give strong support to the photo-ionization theory, and also indicate that corpuscles may have some influence on the outermost F region. Meteoric showers and thunder storms have also been found to increase the ionization of the ionosphere.

The origin of stratification of the ionosphere into E_1, E_2, F_1, F_2 etc. regions is still not definitely

known. Of the various suggestions one may be mentioned. The four regions beginning from E_1 might be associated with the four different ionization potentials of atomic and molecular oxygen and nitrogen. Division of F into F_1 and F_2 during day may also be due to upward movement of atmosphere due to temperature expansion. The origin of 'D' might be connected in some way with the formation of ozone at a lower layer.

Mr. G. R. Toshniwal

Prof. Mitra was followed by Mr. G. R. Toshniwal of the Allahabad University. Mr. Toshniwal divided his remarks in three portions, the first part summarized the work done at Allahabad, the second contained a critical review of the work done outside India, and the third dealt with the need for further research on Ionosphere in India.

Work done at Allahabad—The F-layer equivalent height was found to be about 250 kms. and the E-layer height to be about 100 km.

Even during the night sometimes the ionization of the F-layer was found to increase suddenly.

The rare phenomenon of occurrence of the magneto-ionic triplet, as foretold by theory, has also been successfully observed at Allahabad. At times a jumble of peaks has been also seen during sunset and sunrise periods. This phenomenon, Mr. Toshniwal suggested, appeared to be due to the undulatory structure of the F-layer, and also to the possibility of arrival of echoes from a non-vertical direction.

Observation taken during the last lunar eclipse of 19th January, showed a marked decrease in the height of the F-layer.

The measurement of ionization of the E-layer carried out in April of this year by using a low power transmitter was illustrated by means of a slide. The ionization showed a semi-durnal variation and was explained to be due to strong absorption of the waves during the midday period. The absorption was assigned to the formation of ionized layers below the E layer during the midday, thus supporting in a way Mitra and Syam's theory of a D-layer.

Study outside India—A critical review of the study of Ionosphere in other countries was then given. The possibility of the existence of a G-layer above the F-layer, due to the work of Kirby and Tudson of the National Bureau of Standards in America, was pointed out.

The F_2-layer has been found to show during summer one maximum of ionization at about 9 in the morning and another at about 8 P.M. This has been explained by Appleton to be due to high molecular temperature of the upper atmosphere, which causes a low air density at those heights and consequently a low electronic density during summer midday period. Kirby and coworkers in America regard that this is due to the fact that the penetration frequency measurement during summer midday periods is incorrect because of increased absorption.

The presence of high temperature in the higher altitudes has been inferred from some experiments on sound. In the case of very large explosions it is frequently found that while the sound cannot be heard for more than 30 to 50 kms. round the explosion, it is again heard at places very much further away, at distances of 150 200 kms. from the explosion, and often quite loudly. This phenomenon has been explained by Whipple to be due to an increase in temperature with height after about 35 km. Such an increase in temperature increases the velocity of sound in the upper regions and can easily explain the *skip distance phenomenon* in sound propagation.

Mr. Toshniwal while disagreeing with Appleton supported the absorption theory of Kirby and others, in view of the form of the E-layer ionization curve obtained at Allahabad which had a similar double hump structure. It was suggested that in order to finally settle between the two rival views it was essential to study the ionization of the F_2-layer in summer with high power in the aerial. If Appleton's view is correct then the transmitted pulses, however strong, will indicate the same ionization, but if the absorption theory is correct, then by using stronger pulses only one maximum will be found at noon.

It has been known now for over two and a half centuries that there are more or less regular daily variations in the height of the barometer, culminating in two maxima and two minima during the course of 24 hours. The semidiurnal variation shows a maximum

and minimum at 10 o'clock A.M. and P.M. and 4 o'clock also both A.M. and P.M., respectively. All explanations given so far have proved illusory. Mr. Toshniwal pointed out the parallelism existing between the F_2- ionization and the semi-diurnal variation of the barometric pressure and suggested that if Appleton's view be correct then the same cause may be responsible for the two phenomena.

Need of further work in India—Though considerable work is being done in other parts of the world, yet there is practically no datum available for tropical countries, which will be very helpful in explaining various problems. The observation of as many as a dozen multiple echoes of different intensities at Allahabad shows a definite need of studying their polarization. The lunar eclipse phenomenon also needs further confirmation; and more data on the ionization of the various layers collected in India will be very useful in deciding about the various theories.

Professor M. N. Saha

Prof. S. K. Mitra, in his opening address, has talked of the "Ionosphere," and has given details of experimental methods perfected within recent years for its study and given you an admirable summary of the results so far obtained. It may be mentioned that 'the ionosphere' is only a phase for the upper Atmosphere extending from 20 kms. upwards, and there are several methods available for its exploration. These are :

(1) Direct studies, by the sending of pilot baloons, stratosphere flights etc.; such studies are continued only to the lower layers.

(2) Investigation by radio methods as sketched out by Dr. S. K. Mitra and the other speakers.

(3) Investigations of the spectra of the Aurora and the Night Sky.

(4) Investigation of the upper Atmosphere from studies on the propagation of sound through it.

(5) Investigation of the Ozone content and its periodic variations.

(6) Study of the fall of meteors, fire balls and metorites through the upper atmosphere.

My submission is that we can hope to obtain a complete picture of the upper Atmosphere when the materials collected from these different lines of study are utilized in a synoptic study.

My own work is an attempt on these lines, and is entirely theoretical. The problems which I am going particularly to discuss are very ably summarized by Dr. Mitra in the concluding parts of his address.

It is now well-established that the ionization of the E_1, E_2, F_1,-layers is undoubtedly due to sunlight, as early contemplated by Schuster. But the mechanism of ionization has not been rendered clear. In fact, Swann questioned the capacity of ultra violet solar rays to produce the amount of requisite ionization. He was followed by Chapman who calculated, from variation of ion-content in the E-layer, the coefficient of recombinations, and the number of ions which must be produced by sunlight to maintain the requisite amount of ionization. Chapman showed that if it be supposed that the sun radiates like a black body at a temperature of 6000 ° K, and rays possessing a wavelength $<$ 1350 A units are capable of ionizing the atmosphere, the required amount of ionization can be maintained. Many investigators do not appear to be satisfied with Chapman's calculations, for in a recent note to *Nature*, Miller invokes the aid of soft X-rays supposed to be emitted from the sun, for maintaining the ionization.

It can be proved from recent Spectroscopic investigations that Chapman's assumption that 9 e. Volt rays can produce ionization in the consituents of the solar atmosphere is totally erroneous. The chief constituents are molecular O_2 and N_2, and probably atomic O and N, as is revealed by the spectra of the Night Sky, and the Aurora. There may be small quantities of He, but its existence is not yet spectroscopically established. Recent investigations show that the minimum ionization potentials of N_2 is 15.52 volts, that of O_2 is 12.1 volts and those of O and N are 13.56 and 14.48 volts respectively. If we recalculate the ionization of the atmosphere using these data, it is found that the sun, if it be regarded as emitting like a black body at a temperature of 6000 ° K cannot maintain the observed ionization of

the upper Atmosphere. We are thus placed within the horns of a dilemma as the radio experiments establish it beyond doubt that the ionization is due to some kind of light coming from the sun.

In fact, the night sky data establish the point beyond doubt. The negative bands of nitrogen, which have been conclusively shown to be due to N_2^+, occur very strongly in the Aurora, but very feebly in the night sky, but Slipher of the Lowell Observatory Arizona, showed that the N_2^+ bands occur very strongly in the morning sunlight, when the upper atmosphere is just being illuminated by sunlight, as well as in the evening hours, when the last rays of the sun are disappearing from the upper atmosphere. The bands weaken during the night. It is therefore clear that the solar rays contain radiation capable of producing the upper state responsible for the excitation of N_2 to the upper state of N_2^+. Calculation shows that the energy required for this stimulation is nearly 21 volts.

We are therefore forced to abandon the idea that the sun radiates like a black body, a view long advocated by the present speaker. He has recently carried out certain investigations which show that if it were possible to observe the ultraviolet part of the solar spectrum, which is unfortunately cut off by the Ozone absorption, it would be found that the following lines would appear as intensely bright lines on a continuous back ground.

The early lines of Lyman series of hydrogen $L\alpha$, $L\beta$.. energies 10.12, 12.0 e volts.

The fundamental line of He, λ 584, energy 21.12 volts. There may be certain other lines of metallic origin.

The investigations on which these conclusions are based are entirely astrophysical and deal with a general theory of emission from stellar atmosphere. As the results are not yet completed, the results are given out with certain amount of hesitation.

The remaining part of the address deals with the action produced by these rays on the constituents of the earth's atmosphere, and shows that they are capable of explaining the night sky spectrum, as well as to some extent, the layer ionization of the earth's atmosphere. It is opined that the upper atmosphere is largely made up of atomic Oxygen and Nitrogen, which may partly account for the observed bending and acceleration of sound rays when propagated through the upper atmosphere. The speaker declines to accept the recent theories which assign to the highest layers a temperature of 1200° C.

Mr. P. Syam

Prof. M. N. Saha was followed by Mr. P. Syam, research scholar working in the Calcutta University. Mr. Syam gave an account of how they have been able to detect echoes from a virtual height of about 55 km., giving direct proof of the existence of a low layer at this height, during the day-time. Besides the echoes, which are of infrequent occurrence, they have obtained other evidence in support of the existence of this layer. It has been found that during the daytime there is a frequency band which is reflected from the E region. The upper limit of the frequency band is due to penetration of the E-layer and may be termed the 'penetration limit'. The lower limit, which may be termed the 'absorption limit', is due to absorption by the D-layer on account of large collisional frequency present therein. There are other reasons which point to the conclusion that the complete disappearance of echo, as we have observed, cannot be caused by the formation of a diffuse E-layer boundary and lowering of the same in daytime.

The formation of the D-layer may have some connection with the formation of ozone, though recent investigations show that the ozone layer may actually be at a somewhat lower height than the D-layer.

Dr. S. K. Banerjee

Dr. S. K. Banerjee, Offg. Director of observatories sent the following summary of his observations.

The maximum of region E ionization is reached at a height of about 100 Km. above ground; this is the level where the lower edge of the aurora is met with. Magnetic phenomena support the existence of sunspot period in atmospheric conductivity at a height of 90 Km. and upwards. The ionization at sunspot maximum appears to be about 50% to 60% greater than at sunspot minimum.

The experimental ratio of summer noon to winter noon ionization is about 2.2 for region E and about 1.5 to 1.8 for region F; there is a corresponding variation in magnetic activity.

The influence of the earth's magnetic field is such as to make the ionosphere an aelotropic medium and, owing to the difference in the group velocities of the two components, a single wireless pulse may be split into a doublet. Magnetic storms are connected with abnormal ionization and this is probably associated with high speed charged particles from the sun.

Large scale motion or wind in the ionosphere tend to produce corresponding magnetic variation. The most typical example is the relationship between the lunar atmosphere tide and the lunar magnetic variation found by Chapman. There seems to be an extraordinary variability in ionospheric weather and it would be interesting to correlate them with magnetic variability.

It seems to be established that the sudden appearance of bursts of abnormal ionization is associated with thunderstorms. According to Wilson thunderstorms influence upper air ionization either by 'run away' electrons or by ionization by collision produced at high levels owing to the intense electric fields involved.

If thunderstorms have effects on ionosphere then we should expect some relationship between magnetic storms and thunderstorm activity. Brook's work indicates close relationship between thunderstorm activity and sunspots.

Wilson supposes that if the positive potential of the upper part of a thundercloud is suddenly destroyed, then there would be a sudden rising of the negative potential at the bottom of the cloud, which might result in a discharge to the earth. The sudden rising of the potential at the bottom of the cloud will enable 'run away' electrons, which have been produced within the cloud itself and have no longer to traverse a retarding field above the cloud, to reach the upper atmosphere or to be bent round by the magnetic field and get to earth. Schonland's experiments involving use of a single Geiger counter do not appear to be sound and point to the need for further work on 'run away' electrons.

Discussion

The main addresses were followed by an interesting discussion on the subject.

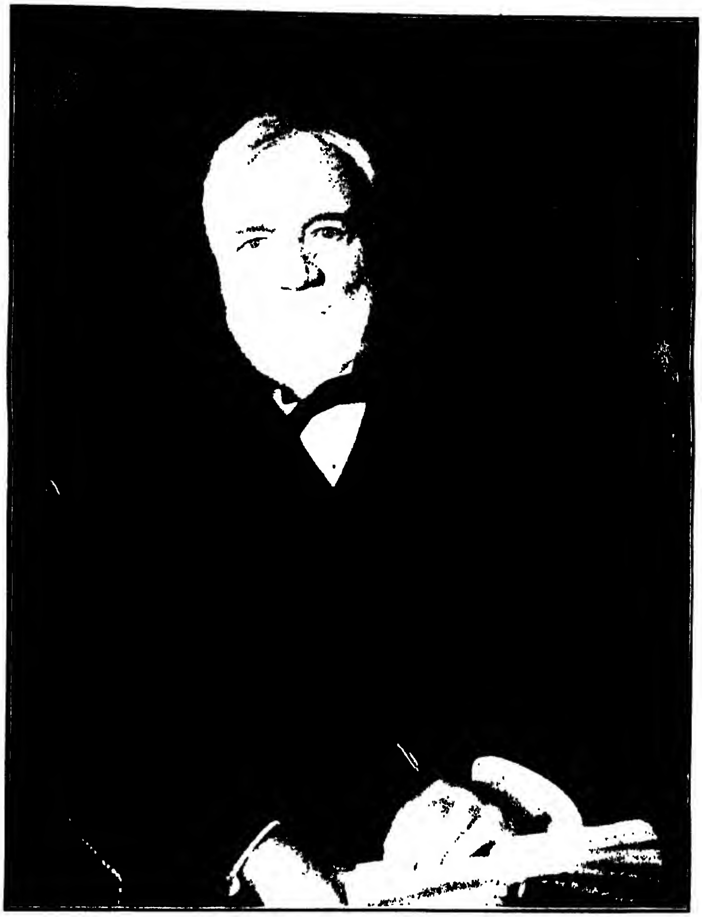
Prof. A. C. Banerjee of Allahabad University opined that a temperature of 1200° absolute in the ionosphere as outlined by Prof. Mitra would mean a lot of radiation of heat waves towards earth. He, therefore, thought if such a temperature prevailed in the outer atmosphere, the temperature on the earth would be much higher than what it actually is. Prof. M. N. Saha pointed out that such a high temperature is molecular temperature at those heights and since the density of air at such heights is very low the heat capacity is very small and hence the the radiation, if any, will be very little. Mr. G. R. Toshniwal said that the matter was still controversial.

Sir L. L. Fermor showed a keen interest in the similarity of barometric pressure curves and the F_2-layer ionization curve as pointed out by Mr. Toshniwal and wanted to have further information of any such co-relationship of ionosphere measurements with other data of interest to the geologists.

In declaring the symposium closed, Sir L. L. Fermor referred to the importance of the study of Ionosphere especially in view of the expected development of Broad-casting in India. Pointed attention was drawn towards the admirable work done at Calcutta and Allahabad in carrying out such a study under great hardships. Such work is being done in England, America, Australia, Japan and Canada at considerable expense by their respective Radio Research Boards financed almost entirely by their respective governments, and other charitable trusts like the Carnegie Institution.

For carrying out successfully the study of the Ionosphere costly apparatus and a band of workers are needed, and since the funds at the disposal of the Universities are very meagre, Sir L. L. Fermor emphasized the need of State help for this class of scientific work.

In Memoriam



Andrew Carnegie

Millionaire and Philanthropist

BORN: Scotland, Danfermline, Nov. 25, 1835.
DIED: Lenox (Mass.), Aug. 11 1919

His Theory of Wealth :—

"This, then, is held to be the duty of the man of wealth: to set an example of a model, unostentatious living, shunning display or extravagance; to provide moderately for the wants of those dependent upon him; and, after doing so, to consider all surplus revenues which come to him simply as trust funds which he is called upon to administer,......the man of wealth thus becoming the mere trustee and agent for his poorer brethren."

SCIENCE & CULTURE

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Electricity–its Use for the Public and for Industries

The appointment by the Bengal Government of a committee* to enquire into the rates charged by the Electric Supply Companies was an event which passed entirely unnoticed by the daily press. Yet events like this ought to receive as much attention and comment from the upholders of public liberty as the more stirring and spectacular political questions, for the growth and maintenance of civilized life in a country depends not only upon proper solution of political problems but, to a greater extent, upon economic development. Countries, like Mexico and certain other South American Republics, enjoy full political liberty, but they count very little in the world's politics as they are left far behind in economic development, and the standard of civilization reached by them has not been as high as that reached by the U. S. A. or the West European States. In this article we wish to invite the attention of our readers to the much neglected problem of public supply of electricity which, now-a-days, is a main factor in economic progress and in which the public in this country has not so far taken any intelligent interest.

It is well known that the growth of civilization is mainly due to the greater utilization of power for the use of man. In early times, man had increased his power by the enslavement of his fellowmen and domestication of animals like the horse, the cow, the elephant and others ; but a far greater source were the forces of Nature. Wind-power, power of flowing rivers have all been utilized in the middle ages, but the total power derived in this way was extremely small. It was only during the nineteenth century that man was able to grasp fully the problem of development of power, and evolve the proper machinery for the utilization of the huge reserve of power lying dormant in coal and petrol deposits, in running streams, and in waterfalls. He has also now some idea of other sources of power stored in tides, in the

Appointment of a committee for enquiring into the rates charged by the Electric Supply Companies by the Bengal Government :* The Committee was appointed in deference to a resolution passed by the Bengal Legislative Council, and consists of a retired High Court Judge, the Accountant General of Bengal, and a representative of Commerce. Complaints have been made already by the Commercial Gazette (Monday, 26th August, 1935) against the composition of the committee which contains neither a representative of popular interests, nor any technical expert having no interest in the electric supply, and thus appears to run counter to the resolution passed by the Council.

heat of the interior of the earth, but has not yet been able to develop the proper machinery for harnessing them.

At first the steam engine had undisputed sway of the field so much so that the nineteenth century has sometimes been styled as *the Age of Steam.* The designation is justified, because the steam engine has been the main factor in ushering the 'Industrial Revolution' in the early part of the nineteenth century. But if the past century has been the age of steam, the present age may be appropriately called *the Age of Electricity*, for it has witnessed the world-wide development of national and regional schemes of electrical power-generation and transmission. The preference of electricity for development of power over other systems of power-generation is due to its inherent advantages, and is likely to increase with time, for electricity can be easily generated from coal, petrol, alcohol, waterfalls, volcanic power and tidal forces. It can be easily transmitted over large distances and can be divided and subdivided in any proportion, and supplied for all kinds of domestic use, for traction, and for all kinds of industries, big and small. The machinery can be easily handled even by the untrained. It is therefore no wonder that electricity should be gradually driving out all other methods of power-generation and a time may come when animal power, as well as the old-fashioned steam engine may become extinct like the Dodo; and all the individual human occupations like cooking, lighting, etc. and private transport, as well as all large scale operations in agriculture, industry and transport will be done through the agency of the almighty Electricity.

The Political and Sociological Problems

The growth and development of such a potent method of power generation brings with itself its own political and sociological problems. At first, the advantage is all with the pioneers who develop the new machinery, form themselves into companies, and offer to the public their services at cheaper rates and greater efficiency than the existing concerns. The electrical concerns have thus invaded all fields, illumination, transport, power supply to industries and for domestic use, and the older systems find it extremely difficult to survive in the face of competition of electric supply companies. Thus about fifty years ago, gas was universally used for lighting houses and for cooking purposes. The invention of the glow-lamp made the position of the gas industry precarious, and it was saved only by the discovery of the thorium mantle. But the invention of new kinds of bulbs which yield ten times more light than the older lamps for the same consumption of power has again rendered the position of the gas-industry extremely precarious in this field. At present, it survives because gas is still found to be the most convenient material for domestic cooking, and for heating purposes in general, for in this line electricity is yet far more expensive; but probably at no distant date it will be as cheap as gas. In transport, the electrical tramways which are now used for mass transport, use huge quantities of electricity and they have driven all old-fashioned horse-driven trams and transports almost completely out of the field in big cities, though the emergence of the automobile has cut down the monopoly of the tram-line companies to some extent. But if some more convenient method of storage of electrical power is invented in future, the automobiles now driven by petrol engines may in future utilize electrical power. Petrol will then be used only for generation of electricity, and the tanks now supplying petrol to motor cars may be replaced by charging stations.

In many countries, particularly those which have good water-power and no coal or petrol, like Switzerland, Sweden and Italy, electrical power derived from water is now almost exclusively used wherever possible, for the experiences of the last world war showed that no country can consider itself secure when it has to depend upon a foreign country for its supply of the raw material for power, *i.e.*, for coal or petrol. The supply of these commodities may be completely cut off during times of war throwing the whole body-politic completely into disorder, and inflicting great hardships on the people. The post war tendency for all countries has been to devise methods for becoming completely self-sufficient, and independent of foreign supply as regards power. The use of electricity for major and minor industries is also increasing daily, for wherever the cost is the same or even slightly higher, the manufacturer and the private owner always prefer electrical power or

account of general cleanliness, greater adaptability and flexibility of the electrical power supply.

It is clear that when the control of a commodity of such vital importance as power supply passes into the hands of a few big companies presided over by powerful bosses, there arises the danger of great misuse of privileges, for there is a risk of exploitation of the public for the advantage of a few. The companies may dictate their own prices which may bear no relation to the cost of production, as in India at present; or in league with other powerful concerns, they may give preferential rates to certain groups of manufacturers in which they themselves have some interest, in order to crush small capitalists or other rival groups. Or they may be working on a system which may completely break down at times of emergency, such as a great war, thus throwing the whole country into confusion. They may also charge such rates that the growth of industries may be materially retarded.

Generation of Electrical Power : A National Concern

For the purpose of safeguarding national and private interest the governments of most countries in the world have found it necessary to exercise stricter control over the generation and public supply of electricity. At the same time, private enterprise should not be killed entirely. To give an idea of such measures, it will suffice to describe briefly the control exercised in England. The underlying idea is that electricity should be supplied at as cheap rate as possible to the public for all purposes, and an easy and uninterrupted supply of it should be secured just like the supply of water to a big city.

Prior to 1926, the state of affairs in England, though much better than that at present existing in India, was not very satisfactory. The British public supply of electricity was carried on by supply companies and municipal authorities and the public were at the mercy of supply companies who, like their counterparts in India, showed extreme reluctance in reducing their rates even when it was possible for them to do so. By successive legislation since 1882, the government of the United Kingdom have now brought under control the production and distribution of electricity. The Great War necessitated an entire change in the general aspects of the production and distribution of electricity, and radical modifications in the existing laws were proposed. "The exigencies of the War revealed electricity as a vital agent of industrial production. They brought out sharply the defects in the legislative situation by which cooperation in production and distribut'on was impracticable, and isolated development was fostered. The inter-connection of generating stations, desirable with a view to economy in plant, coal, and other items of cost, was urged upon electricity undertakers by a Board of Trade circular in May, 1916, and a special department was formed under the Ministry of Munitions to organize the supply of Electrical Power". A number of committees were appointed and the report of these led to the passing of Electricity Supply Act in 1919 (amended by the Act of 1922). The Act provided for the appointment of five Electricity Commissioners, whose general duties were defined as *promoting, regulating, and supervising supply of electricity.* The appointment of these commissioners was in itself a *statutory* revolution. The Act inspired confidence in the future of the industry; it broke down many prejudices, municipal, political, and official. The next great change effected was in January 1925, when the government of the United Kingdom appointed a committee under the presidency of Lord Weir, to consider the general question of immediate and future development of electricity in the country. Acting on the findings of the committee, the Government introduced a bill in the House of Commons in March, 1926, which was passed into an act, called *the Electricity (supply) Act of 1926.* The greatest change introduced was the establishment of a *Central Electricity Board* having a constitution similar to that of an industrial company outside of direct parliamentary control. The Board aims at complete reorganization and control of generation of electric energy for the whole of Great Britain. The main functions of the Board were :—

(1) To construct giant power stations located in industrial areas and operated by public supply undertakings under the directions of the Board in accordance with a technical scheme for the country.

(2) To erect a comprehensive net-work of main transmission lines covering the whole country and inter-connecting all selected stations where

generation would be concentrated. (Popularly known as the *Grid system*).

(3) To standardize the frequency of the supply.

(4) To supervise the scale of electrical energy and to authorize distributions at cost price.

"This proposed not a change of ownership, but the partial subordination of *vested interests in generation to that of a new authority for the benefit of all*, and this only under proper safeguards and in a manner which will preserve the value of the incentive of private enterprise".

It was estimated that by thus concentrating the production of electricity, the average working cost of energy would fall from .91d as recorded in 1925 to ·4d (·37 as) per unit. Also, "while the large industrial consumer would be able to obtain his power requirements at ½ d per unit, the nationa average for all supplies would be in the vicinity of 1d." The report of the Weir Committee contained a picture of what would be aimed at to secure efficient generation of high tension energy in 1940 as compared with the year 1925. The salient comparisons are given in the following table.

Present Position

As a result of systematic planning and control of supply companies by the Central Electricity Board, the position of the United Kingdom in the generation and supply of electricity has been steadily improving. The actual units of electricity produced in 1934-35 are according to the League of Nations Statistical Year-book 20,690 million units (1 unit = 1 Kilowatt hour) which works out at the rate of 440 units per head of the population. More than 70 per cent of this quantity has been supplied by the Grid Superpower Stations controlled by the *Central Electricity Board*. The total yield of electricity represents almost a ninety per cent increase over the figures for 1926. Most of this electricity is manufactured from coal as the United Kingdom is very rich in coal deposits, but very poor in hydro-electric resources. Of this amount more than 60 per cent is used i traction and other industries, and 40 per cent i public lighting and domestic use. The rates charged from the public for domestic use vary from place to place, but the following figures for a number of provincial cities of England will prove instructive.

TABLE I

	1925	1940	increase
Units sold per head of population	110	500	430%
Maximum load	1,844,000 K.W.	8,135,000 K.W.	
K. W. installed	3,096,000 K.W.	10,000,000 K.W.	
Spare plant	68%	25%	
Units sold	4,016,000,000	21,385,000,000	
Load factor	24·9%	30%	
Total Capital			
Generation	£73,680,000	£127,000,000	
Distribution	£88,070,000	£243,500,000	
Total revenue	£34,256,000	£ 88,100,000	
Average price per unit	2·047 d	1 d or under.	

(The quotations and the table are from *Ency. Brit.* 14th Edition, 8)

It is thus seen that the *production of electricity in England has been completely nationalized*. Only the distribution has been left in the hands of private supply companies. The cost of production has been reduced considerably and hence the selling price to the public is being continuously reduced.

It will be noticed that the figures are lowest for a large city like Hull situated near a coal area, and highest for smaller cities (Derby), and for those farthest from the coal area (Portsmouth). The charges for London given here are taken from a paper published by *The Engineering Gazette*

TABLE 2

City	Population in 10^5 (lacs)	Units consumed for domestic purpose. (in K.W.H.) Total (in million). in K. W. H.	Per head	Revenue (in pounds) sterling 10^3	Rate (in pence)
East Ham	1.41	9.73	69	75.4	1.85
Ilford	1.40	15.57	140	105.2	1.62
Hull	3.66	29.28	80	183.60	1.50
Portsmouth	3.10	17.50	56	186.00	2.55
Derby	1.71	10.50	62	91.00	2.08
West Ham	2 97	10 41	35	93 00	2.15
Calcutta		—	·		3.0d
London		—	--	—	·36d
Allahabad		--	—	—	5.0d

(Taken from *The Electrician*, 1934.)

for an all-electric house in London where all *domestic work* (cooking, cleaning, heating of the rooms, ironing, maintaining a radio-gramophone and an electrically maintained clock) is done by electricity. The charges vary from ½d per unit in summer, to ¾d in winter and the average works at ·37d. These figures show that the expectation of the Electricity Commissions expressed in 1926 have been fulfilled as regards London five years earlier, though in the case of provincial cities, the rates have not yet come down to 1*d* for domestic purpose, but is on the way to become so. These rates may be compared to those in two typical Indian cities, Calcutta, and Allahabad. We shall consider the case of public supply of electricity in India in a later article, but this much may be said that in Calcutta. electric supply for domestic use should be as cheap as in London, because it possesses all the advantages of London. It is near the coal area, has a large mass of population concentrated in a small area, and a large percentage of people are electrically minded and probably the load factor is quite high. But the actual figures show that the rates are eight times higher than in London. In a city like Allahabad the rates charged for domestic consumption should be the same as that at Portsmouth, but actually rates charged are two and a half times higher. These figures conclusively prove that as far as public supply of electricity in India is concerned, the public is entirely at the mercy of companies which are plain and simple *profiteers*.

The Jute Fibre

Pulin Behari Sarkar

Department of Chemistry, Dacca University.

In Bengal, people in general are perhaps as familiar with jute as with their staple food, rice; both crops are equally important, and the low price of the former and the failure of the latter affect them almost equally. Jute is practically a monopoly of Bengal, though it is grown in some parts of Assam and Bihar and Orissa. Soil and climatic conditions of no other country have yet been found so favourable for its growth as of Bengal. Repeated trials were given to it in Brazil, Egypt, Java, Philippine Islands, and other places, but in vain. It did not succeed even in Burma. Jute is said to be cultivated to some extent in China, producing annually 35000 bales on a rough estimate. It does not appear to be an article of much importance in trade of that country, as large quantities of Indian goods are imported by her every year. Jute cultivated in Sudan as an experiment has been found on examination in London to be much inferior to Calcutta jute of fine quality.

According to Government statistics, of the total area of 24 million acres under crops in Bengal as many as 3.06 million acres (approximately 12.5%) were under jute in 1930, while only 0.43 million acres represented jute cultivation that year in Assam and Bihar & Orissa taken together. The total area under jute in a normal year is about 10% of the total cultivated land in the province of Bengal. During the last 20 years (1914-34) the maximum area under jute in Bengal was 3.6 million acres in 1926-27 and the minimum 1.45 million acres in 1922-23. And since 1931 it is between 2 and 2.5 million acres on the average. The jute restriction scheme of the Government of Bengal will, it is expected, lower this figure still further within a year or two.

As regards the actual yield of jute, the total production in 1932-33 was 8,663 thousand bales (5 maunds making a bale). Consistent with the maximum area under jute cultivation in 1926-27, the highest yield was reached that session, the figure for the year being 12.30 million bales. The minimum production during the last 20 years was in the session 1922-23, 5.93 million bales having been produced. The average production of jute in Bengal under usual conditions lies between 40 and 50 million maunds per year, that is to say, nearly a maund per capita. Extraordinarily large amount of jute was produced in Bengal during the five years following the session 1925-26 (the average yield of jute being 10.5 million bales per year) in which the maximum phenomenal rise was attained, jute selling at the rate of Rs 25/- per maund in Calcutta that year. Apart from other factors which, to a more or less extent, influence the price of jute, it has generally obeyed the simple demand and supply law-- with excessive production the price has gradually gone lower and lower and it has now reached the incredible figure of Rs 4 to Rs 5/- per maund.

Let us now consider the fortune it brings to Bengal every year. In 1929-30, for which the figures are at hand, the total value of exports of Indian products (practically cent per cent raw) was Rs 3,108, 055,000, of which jute (both raw and manufactured) represented 25.45%. Or, in other words, 79.10 crores of rupees came to Bengal alone practically, of which a fairly large share went to the cultivators. The total value of exports of raw jute and manufactures reached the climax, as has already been indicated, in the year 1925-26, bringing 96.78 crores of rupees in all, in respect of jute. The average figure is well-nigh impossible to get, as it varies between wide limits. Roughly speaking, Bengal derived an income of 50 to 80 crores of rupees annually from jute alone, previous to the year 1929-30; since then, as is well known, it is coming down rapidly, the figure for 1930-31 being 44.77 crores and that for 1930-32 only 33.11 crores. It is needless to describe the sad plight of the Bengal peasants and middle class people as a consequence of this abnormal fall in the price of jute. The reasons are many and varied; over-production.

as is generally held, is not the only factor responsible for this, though it is doubtless the main factor. Leaving alone the world-wide economic distress for which no simple and valid reasons are yet available, jute has been hard hit by its substitutes discovered in Germany and other countries where it has not been possible to grow jute.

Many people have the idea that during the last Great War a huge quantity of jute in excess over the normal consumption was used and the Bengal cultivators simply rolled in gold at that time; and in their sincere desire to get back the prosperity of the Bengal peasants, they fervently wish for another world war to break out. But the export figures during the war period tell a different tale; in 1913-14 (pre-war) jute brought 59.1 crores of rupees, in 1914-18 (war period) it fell down to 38.73 crores, and in 1917-18 it again rose up to 49.29 crores only. In an average, 2 million bales were exported to Europe during the war period per year, but 3-4 million bales after the war, as also before.

The above represents in a nutshell the position of jute in Bengal. Before considering the various factors which are held responsible for the present dull market of jute, we shall first deal with the chemistry of the fibre. Systematic chemical investigation of jute was taken up in this laboratory by Dr. J. K. Chowdhury and his students as early as 1926, and in the course of the last nine years a large number of original papers on the subject have been published in the *Journal of the Indian Chemical Society*. We shall very briefly consider the contents of some of the papers in so far as they relate to the composition and properties of the fibre.

We are all quite familiar with cotton which is practically pure cellulose. In jute as well, cellulose forms the principal part but it is associated with a complex incrusting matter called lignin and also with some other comparatively simpler gummy substances known as hemi-celluloses. But the cellulose of cotton differs from that of jute in a very fundamental point—the ultimate length of single cells of jute is much less than that of cotton (about 0.6 mm for jute and 30-40 mm for cotton). In the case of jute, these single cells are joined together by the gummy matter, as a result of which the fibre appears very much longer. It is the hemi-celluloses that serve as the cementing material and not lignin as is generally supposed, for when lignin is carefully removed by means of chlorine dioxide jute retains its former structure. But when the hemicelluloses are separated from the delignified jute the fibre falls to very minute pieces.

The jute fibre is slightly coloured due to its association with lignin; when lignin is completely removed by chlorine dioxide, it becomes milky white. The presence of lignin makes the fibre tough and so, practically unfit for textile purposes. Hence lignin must be removed before it can be employed as a textile fibre apparently like cotton. But unfortunately, the tensile strength of the delignified fibre, when moist, is practically nil though in the dry state it is almost as strong as the raw fibre. Hence the removal of lignin while maintaining its strength is the real problem. We have not been able to solve it as yet. Secondly, the delignified fibre is still very coarse and far less pliable and soft than cotton. As the hemicelluloses are soluble in dilute alkali the delignified jute is more or less reduced to its ultimate cells on alkali bleaching. Thus, even if the delignified jute were as strong as the raw, the problem of cottonization of jute would still remain unsolved. When these hemicelluloses are removed, jute is no longer fit for spinning owing to its very short length; the ultimate cells must at least be 15-20 mm long to be of value for textile purposes. It appears doubtful if the natural defect of the jute fibre can at all be removed by any chemical means. If it were possible to achieve this end, Bengal would surely be a very rich province in no time.

It is now an established fact in the scientific world that cellulose is composed of a very large number of glucose units. In the plant kingdom, as is well known, carbon dioxide and water together form formaldehyde, and oxygen is simultaneously liberated in the process. A number of these formaldehyde molecules unite together to form glucose, fructose, which in their turn give us the familiar cane sugar on the one hand and cellulose and starch on the other. Various other sugars are also produced side by side. It is really a very great wonder how the tiny plant produces such complex bodies which have so long defied practically all

human efforts for the elucidation of their structure from such simple substances as water and carbon dioxide. One thing is indispensible for this synthetic purpose, namely, sunlight. Simple sugars have however been made in the laboratory by the illustrious German savant, Emil Fischer, but it has not been possible to go further since his demise. We are waiting for another Fischer to complete the process.

It is a matter of great controversy among the chemists of the present time as to how many glucose units there are in the cellulose molecule. Some hold that the number is very big, while others consider it to be rather small. It has been shown by Staudinger and co-workers that the minimum value lies near about 1·5 lacs. It is now generally believed that all celluloses are identical only so far as their basic composition is concerned but not in their degree of polymerization, that is to say, the number of glucose units forming the molecule varies with different celluloses. In a paper by Chowdhury and Basu from this laboratory, it has been definitely established as a result of detailed chemical examination that jute and cotton celluloses are identical from chemical point of view. Chowdhury and Bardhan have determined the molecular weights of jute, cotton, and bamboo celluloses by the viscosity method and have also found out the size of the molecules from surface tension data under identical conditions, and it has been found that the molecular weight of cotton is the highest, that of the bamboo cellulose is the lowest ; and jute cellulose occupies an intermediate position. The higher the number of glucose units in a molecule, the more resistant it apparently becomes. Hemicelluloses are intermediate products in the process of formation of cellulose from glucose, as is generally believed. They are more resistant than glucose but less so than cellulose. We call the hemicelluloses pentosans and hexosans ; these on hydrolysis give pentose or hexose sugars. Chowdhury and Saha have examined the hemicelluloses from jute and identified glucose, fructose, galactose, arabinose and xylose in the products of hydrolysis. It is worth while to note here that hemicelluloses are not fibrous in their structure but only a pasty substance. There are different theories regarding the transformation of these hemicelluloses in the living plant. Some are of opinion that, on maturing, these form lignin, as it has been found in some cases that with the aging of the plant the percentage of hemicelluloses diminishes while that of lignin increases. There are workers who believe that they are finally converted into cellulose. Wislicenus suggests that in nature both glucose and fructose are formed simultaneously, and while the former forms cellulose the latter forms lignin in the living plant. This, however, cannot explain the case of cotton which contains no trace of lignin. But cotton may be considered as an honourable exception as no other plant has yet been found to contain cellulose without lignin. In spite of the vast amount of research work done in this field, the actual processes going on in the plant are still little understood. It is therefore difficult to say which hypothesis is correct.

The resistant cellulose of cotton we call α-cellulose. Jute contains about 67% of this α-cellulose, and only 7-8% of hemicelluloses. Lignin represents 15% of the raw fibre. Besides these, there are some acid constituents present in the jute fibre. These are galacturonic and glycuronic acids. Chowdhury and Mitra have isolated and identified them definitely. Owing to the presence of these acid members, jute behaves like a tanned fibre and has direct affinity for basic dyes. The presence of these bodies is rather interesting in view of the fact that very few fibres have been shown to contain them. The percentage of these is however very small.

Another peculiar substance is present in the fibre, namely, pectin. To many of us this is no longer a stranger, as large quantities of pectin are now-a-days used in the preparation of jams and jellies. Many fruits are rich in pectin, very noteworthy of which is guava. The identity of pectin from different sources has not yet been established, but Ehrlich believes that they are the same. Jute, however, contains very little of it in comparison with fruits, the pectin content of jute being only 2%. Obviously it cannot be used commercially as a source of pectin.

The jute fibre contains traces of fatty and resinous matter (a bit less than 1%) which can be very readily removed by extracting with a boiling mixture of alcohol and benzene, but not by mere washing with soap. Cotton as well is similar in this respect. The presence of these makes the fibre more or less

impervious to water. When the last trace of the fatty matter is removed, we get what is known as absorbent cotton. This soaks water very readily.

No protein matter occurs in the jute fibre as it is entirely free from nitrogen, but very minute quantities of some minerals are always present—the ash content is 0.5% only. Iron, silica, calcium, magnesium and aluminium have been detected in the ash from jute. The presence of silica is rather difficult to explain if we do not assume it as an earthly impurity tenaciously adhering to the fibre. Calcium and magnesium are attributed to the pectin matter present in jute. It may be mentioned here that even purified cotton is not free from ash, though it contains no pectin.

The air-dried fibre always contains some moisture, the amount of which is dependent on the humidity of the air. Thus, in August it is found to contain 15.75% of moisture, in December 12.01%, and in March only 8.40%. It is to be noted that the fibre does not appear moist to the touch at any time of the year. Considering this fact, it is evidently more profitable for the jute-dealers to sell their jute in July and August rather than in March and April. As is well known, these people always mix some additional water with the jute to counterbalance the loss sustained by it when they sell their commodity in winter or summer.

To sum up, we may roughly represent the composition of the fibre as follows :—

Resistant cellulose ...	67%	
Hemicelluloses ...	7%	
Lignin	15%	
Uronic acids ...	8%	(pectin also gives these acids)
Pectin	2%	
Fat and resin ...	0.9%	
Ash	0.5%	
(moisture	8.4 to 15.75%)	

The chemical nature of lignin still remains more or less unknown though just a century has elapsed since the first investigation for its structure was taken up in the laboratory. In a series of papers published by the writer some light has been thrown on the complicated structure of this extremely complex body. A detailed description of the results obtained here will be of little interest to the general reader. Briefly speaking, there are reasons to believe that in jute lignin, and cellulose are not chemically combined, though some workers in this field think so; jute-lignin is an aromatic body whose molecular weight lies near about 830; just like cellulose, all lignin have the same basic composition but they vary in their degree of polymerization in which time factor plays an important rôle; carbohydrates (sugars) are no constituent part of the lignin molecule and so on. Our present day knowledge about lignin may form the subject matter of another article.

Cellulose and its compounds are rapidly coming to our use more and more; artificial silk is purely a cellulose product, so are celluloid, paper, gun cotton, lacquer varnishes etc. For artificial silk jute would be surely a very costly starting material as it can be easily made from wood. For paper making as well, it is not so suitable as the fibres are too short. Moreover, paper can be more cheaply made from bamboo, grass etc. For manufacturing gun cotton, celluloid, lacquer varnishes etc., cellulose nitrate (wrongly called nitro-cellulose) is generally used. In this laboratory, Bagchi has prepared cellulose nitrate from jute and shown that by suitable treatment it can be made quite as stable as that made from cotton. We are now in a position to suggest that jute may with advantage replace cotton in this case.

The fundamental defect for which jute is comparatively less important commercially is its lack of durability and high lignin content. It is a well known fact that when exposed to dampness the fibre loses much of its strength; the decaying process is supposed to be bacterial. It has been shown by the author that the deterioration of jute fibre with time is quite negligible if it is kept in a dry place. When exposed to dampness, the fibre becomes brittle and loses much of its strength very rapidly. It has also been found that treatment with formaldehyde, specially in presence of dilute caustic alkali, not only increases its strength about three times but also prevents the bacterial decomposition. This is a very important fact from commercial point of view. It has further been pointed out that lignin serves as a protective coating for the fibre so far as its deterioration is concerned; the

delignified fibre is far more quickly attacked by bacteria than the raw.

In our experiments with the retting of jute in the laboratory we have observed the interesting fact that green jute plant retted in glass or porcelain vessels in the usual way, but in a galvanized iron vessel jute did not ret even in three months. Metallic zinc has therefore a distinct inhibiting action on the retting of jute. This fact may be utilized for centralized retting if necessary.

Baled jute exported to foreign lands formerly suffered what is known as the "heart damage" of jute, the jute in the centre of the bale becoming a spongy brittle mass which could be rubbed into a fibrous powder and was therefore rejected. It was shown by Finlow that dry jute never suffers heart damage, but when damp jute is baled, a rise of temperature up to 40°C takes place in the interior of the bale due to bacterial action which is apparently hydrolytic. About 60% of the fibre becomes soluble in water or dilute acid or alkali. It loses all tensile strength and is therefore quite unfit for spinning. The more tightly the fibre is packed, the lower the proportion of water required for the development of heart damage. Kutcha bales (280 lbs) with 30% moisture and pucca bales (400 lbs) with 25% moisture will produce heart damage, but not with less water. Necessary precautions are accordingly taken now-a-days while baling jute for export to avoid heart damage.

As regards the uses of jute, by far the most important is for making gunny bags; about 60% of the world consumption in raw jute is used for sacks. Until lately it was considered as the cheapest packing material. But many substitutes have been found out and it is no longer so. Germany is using her own fibre for sack making, while Japan is exporting powdered sulphur to India in rice-straw bags. With the coming of economic depression, there has been a reduction in world trade and consequently in the demand for packing; secondly, there is the competition of inexpensive paper and other substitutes, and thirdly, there are the exchange restrictions which make it difficult to move jute goods freely, and facilitate matters for competing goods. As a result market has become extraordinarily dull, and new uses for jute must be found out. In Germany, for instance, the war had taught the manufacturers the importance of the substitute for jute, and when normal conditions returned to Germany, jute industry had difficulty in regaining the old markets for jute goods. They were thus compelled to find new uses for jute, and they have undoubtedly been successful in their research efforts.

Jute has lost, for the time being at least, its principal recommendation, namely, its comparative cheapness. Four main factors are held responsible for the inroads which the substitutes have made upon the jute industry. Of the first importance are the cheapness and the stability of price, both of which are illustrated in the case of paper bags, which have kept a steady price level; the other reasons are better durability, as in the case of cotton and sisal, and the desire of certain countries to utilize their internal resources wherever possible to the elimination of jute and jute fabrics.

Jute trade is thus in a critical state. But it determines, so to speak, the pecuniary condition of Bengal. It is high time that a good deal of research work should be done in order to save her from this crisis. Government of India derives an appreciable income from jute but spends practically nothing either for the Bengal cultivators or for research. The Meston award was until last year a settled fact, the glaring inequity of which has been repeatedly pointed out by Mr. Ramananda Chatterjee, editor of the *Prabasi* and *Modern Review* with irrefutable arguments. It is said that the Imperial Government spends a small percentage of tariff income from agricultural products for research work; as for example, for cotton, timber, tea, lac etc. But Bengal has been unfortunate even in this respect. We do not know what debars the India Government from granting the same favour to Bengal for establishing a jute research institute of her own. The Imperial Council of Agricultural Research is spending lacs of rupees for research every year, but strangely enough, it does not, for reasons unknown to us, include jute in its list of agricultural products. And not a farthing it has granted up till now for research on jute.

We understand Dr. S. G. Barker of the Wool Industries Research Association, England, has been invited to make a scientific survey of the position

of jute in Bengal ; some months ago, we sent him the reprints of our papers on the subject at his request. It may be considered excusable to mention here that he has paid in liberal language a glowing tribute to Prof. Chowdhury and his collaborators for the 'excellent' work done in this laboratory. He ends one of his letters written to the author of this article by saying, "I urge you to go on. The Indian jute industry needs fundamental knowledge of the fibre as the foundation upon which to build the future, and papers such as those of Professor Chowdhury and his school of thought of which you are a distinct ornament, can only do good to the economic welfare of the country, as also fulfilling the function of education and of a university."

But the problem has to be attacked from all possible directions and that as quickly as possible ; evidently, a university chemical laboratory is not the suitable place for this purpose. We are anxiously waiting to see what comes out of the efforts of this eminent English scientist who is already well known for his very valuable researches on wool.

Earthquake shocks recorded by the Seismographs at Alipore Observatory in September, 1935.

Date	Time of beginning I. S. T. H.	M.	S.	Intensity	Epicentral distances (miles)	Remarks
4. 9. 35	7	14	4	Great	2.370	
,,	9	5	36	Slight	2,370	
5. 9. 35	18	6	48	,,	310	Reported to have been felt at Cooch Behar and several other places in North Bengal.
9. 9. 35	11	56	56	Moderate	3,690	
11. 9. 35	19	43	11	,,	3.520	
15. 9. 35	16	58	14	Slight	3,750	
,,	20	0	7	,,	10,570	
18. 9. 35	14	9	36	Tremor	—	
20. 9. 35	7	26	34	Great	4.220	
,,	11	3	6	Moderate	4.130	
21. 9. 35	2	44	14	Slight	4,190	
23. 9. 35	14	58	19	,,	4,100	
24. 9. 35	10	41	4	,,	1,550	
25. 9. 35	4	6	52	,,	3,970	
,,	15	59	43	,,	4,000	
29. 9. 35	12	14	23	,,	1,310	

An Historical Account of the Classification of Thelephoraceae

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The *Basidiomycetes* represents a class of fungi which are included among the most highly developed types. They have been divided into several sub-classes including the *Gasteromycetes* and the *Hymenomycetes*, the latter was characterized by Fires[9] as, "Hymenio externo subdiscreto, sporophoris apice subtetrasporis, sporis spiculis suffultis". It consists of a large assemblage of types, all characterized by the presence of basidia which produce spores exogenously. The definite layer composed of closely packed basidia is known as the hymenium. Each basidium usually produces 4-spores which are either sessile or borne on stalk-like structures, called the sterigmata. Under this sub-class occurs a natural group of fungi, the *Thelephoraceae* which has been characterized as having the hymenium inferior or amphigenous, spread over smooth, rugose, rarely ribbed or papillate surface, coriaceous or waxy in nature and having an intermediate layer of hyphae lying between the hymenial layer and the mycecliuın. It constitutes a small assemblage of fungi; but there exists great diversity of opinion as to whether this group represents an order, family or tribe, and a survey of the different systems of classification published from time to time would bear out the correctness of the statement.

The classification of the *Thelephoraceae* according to old writers was based entirely on external characters; hence, it is not at all surprising that some of the genera which were once included in the *Thelephoraceae* have now been transferred to the *Agaricineae, Polyporae, Tremellineae* etc.

As early as 1729 Micheli[24] described and figured a *Stereum* like plant which has since been referred to *Hymenochaete rubiginosa*, along with several resupinate species.

Willdenow[33] (1787) was the first to constitute and describe the genus *Thelephora*.

Persoon, while attempting to arrange the fungi in a system according to their natural affinities, established in 1796 on the basis of habit. In his "Tentamen Dispositionis Methodiceae Fungorum" (1797) he included these genera along with *Tremella* in a section of his order "*Hymenothecium*" characterized by the presence of fleshy receptacles bearing "thecae" (spore-bearing organs) superficially. Hence it is at not all surprising to see him include several *Discomycetes*, *Pucciniae* and some *Hymenomycetes* along with the true Hymenomycetous fungi as at present understood.

In 1801 Persoon[20] in his "Synopsis Fungorum" divided the Thelephoraceous plants into two genera, *Thelephora* and *Merisma*, which he included in the section "*Gymnodermata*" of the order "*Hymenothecii*", and transferred *Tremella* to the *Discomycetes*. The genus *Merisma* included all the species showing incrustation (e. g. *Thelephora penicillata)*, while the genus *Thelephora* was divided according to habit into three sections:-viz.-*Craterellus* with stipitate forms, *Stereum* with dimidiate forms and *Corticium* with resupinate forms.

In 1809 Link rejected Persoon's *Corticium* on the ground that resupinate habit was not a sufficient distinctive character, for it might be the early stages of many fungi. He recognised only three genera viz. *Thelephora*, *Stereum* and *Merisma*. His *Stereum* included many species with the hymenium characterized by the presence of setae (now regarded as *Hymenochaete)*.

The nomenclature adopted in the well-known Friesian system of classification, which is a modification of that of Persoon, has been adopted as the

starting point of botanical nomenclature in the *Hymenomycetes*, at the International Botanical Congress held at Brussels in 1910. Fires[9] in his "Systema Mycologicum" (1821) established the class *Hymenomycetes* and included in it the *Discomycetes* along with the *Hymenomycetes* proper. He placed the genus *Thelephora* under the sub-order "*Pileati*" and regarded *Stereum* (in the sense of Link), *Phylacteria* (for resupinate species with coloured spores arranged in fours), *Himantia*, and *Leiostroma* (based on texture), as its sub-genera.

In 1825 he[10] distinguished the group *Auriculariníí* under "*Pileati*" and included in it *Thelephora* (species with dark spores arranged in fours), *Auricularia, Phlebia, Coniophora* (with ochraceous or sub-ferruginous spores), and *Stereum* (in the sense of Link).

In his "Genera Hymenomycetum" (1836) Fires[11] again describes the genera *Stereum and Corticium* and differing from Persoon and Link includes species with velvety and smooth hymenium, hymenial surface being coriaceous, remaining unchanged when dry in the former, and also species which are soft and waxy when fresh, becoming cracked when dry in the latter.

The true nature of the hymenium was, however, only understood after the works of Lévéille[16] and Berkeley[1-6] were published. In 1837 Léveillé divided Persoon's *Hymenotheeii* or *Hymenomycetes* of Fries into *Basidiospori (Hymenomycetes* proper) and *Thecospori (Ascomycetes)*. Léveillé was the first to isolate the genus *Hymenochaete* from the *Stereum* on the presence of setae. His genus *Hymenochaete* included species with both coloured and hyaline setae and cystidia. It was Berkeley[2] who first restricted the genus as at present understood to species with coloured setae only.

Tulasne, in 1853 removed the *Tremellineae* and *Dacryomycetaceae* from the neighbourhood of *Thelephoraceae* on the ground that the former groups differ in the nature of the hymenium from the latter, though the genus *Auricularia* was still retained in the latter group. As late as 1872 he[25] regarded it as a third type in the *Tremellini.*

In the same year Tulasne established the genus *Sebacina* which resembles the Thelephoraceous plants in habit and the *Tremellineae* in the structure of the basidia.

In 1874, Fries[12] again revised his system and included in the *Thelephoraceae* the genera *Craterellus, Thelephora, Stereum, Corticium* and *Cyphella* along with *Auricularia* in his "Hymenomycetes Europaei". *Hypochnus* and *Coniophora* were regarded as sub-genera of *Corticium* as previously defined in his "Genera Hymenomycetum" (1836) and the genus *Stereum* was marked off from *Thelephora* in having an intermediate fibrillose layer. He rejected Léveillé's *Hymenochaete* and distributed the species under the genus *Stereum.* But in 1880, Cooke[7] re-established the genus *Hymenochaete.*

In the same year (1874) Rabenhorst marked off the genus *Aleurodiscus* from *Corticium* on the presence of peculiar hymenial structures. This genus was afterwards studied by von Höhnel and Litschauer[14] in great detail (1907).

In 1880 Cooke[7] split up the old genus *Corticium* into two genera *viz.*,—(1) *Corticium* having non-spore bearing organs of the hymenium indistinguishable from the basidia and (2) *Peniophora* with species having cystidia.

An advance in the study of *Thelephoraceae* was noticed during the period 1888-90, when Massee published his "Monograph of the Thelephoreae" where he took such important characters as spores and cystidia in the determination of the species.

The classification proposed in Saccardo's Sylloge Fungorum, Vol. VI (1888) is hardly a natural one. As many as 17 genera have been included in it. The genera *Auricularia* and *Solenia* have been included in the *Tremellineae* and *Hydneae* respectively.

Next important classification was proposed by Patouillard[19] who in 1887 divided the *Thelephoreae* according to the colour of the spores. In 1900 in his "Essai taxonomique sur les familles et les generes des Hymenomycetes" he spiit up the old genera *Thelephora* and *Corticium*, and established for the first time the genus *Tomentella*, the species of which were formerly distributed under *Corticium* and *Hypochnus.* The genus *Helicobasidium*, the species of which were formerly placed by Tulasne in the genus *Hypochnus*, was placed in the tribe *Auricula-*

riales under the family *Auriculariaceae*. The genus *Sebacina*, the species of which were firstly included in *Thelephora* and *Corticium* in the Friesian sense were included in the *Tremellaceae* of the *Basidiomycetae Heterobasidiae*. His family *Aphyllophoraceae* of the sub-class *Basidiomycetae Homobasidiae* included in a single family the *Polypori*, *Hydnei*, *Thelephorei* and *Clavarici* of Fries. He divided the *Aphyllophoraceae* into (1) *Clavariales* containing the genus *Thelephora* along with *Pterula* and *Cristella* in the series *Thelephorei*, and (2) *Porohydnales* which correspond to the *Polypori*, *Hydnei* and some *Thelephorei* of Fries. The genera *Cytidia*, *Aleurodiscus* and *Cyphella* along with other genera are placed in the tribe *Cyphellae*. The series *Corticii* of the tribe *Odontiae* contains such genera as *Hypochnus* and *Corticium*, whereas the genera *Stereum* and *Cladoderris* are included in the tribe *Sterea*. The genera *Phylacteria* and *Tomentella* are widely separated and placed in the *Hydneae* while the genera *Hymenochaete* and *Coniophora* are placed in the section *Igniarii* of *Fomes* and *Merulii* respectively.

Next classification to appear was that in the Natuerlichen Pflanzenfamilien, in which the sub-class *Hymenomycetes* was divided by Hennings[13] into six orders, one being the *Thelepharaceae*.

Quelet[21] included *Thelephora* and *Kneiffia* in the *Hydneae* and practically placed *Sparassis* in the *Thelephoreace* (Enchiridion Fungorum, p. I.). Quelet[22] subsequently modified his system in his Flora ('88, p. 16) but still kept *Stereum* and *Sparassis* together.

Maire[18] in 1902 placed the resupinate genera of *Peniophoraceae* (including *Stereum*) and *Phylacteriaceae* (*Thelephora*) in the section *Cantharellineae* whereas *Corticium*, *Hypochnus* and *Kneiffia* formed a section, *Corticiaceae*, of *Polyporineae* under the group *Euhymenii*.

Next important classification was suggested by Burt[7] in 1913. His monograph of the North American Spe   of *Thelephoraceae* was published in the Annals of the Missouri Botanical Garden. The family is here taken to include the following genera viz.—*Craterellus*, *Cyphella*, *Exobasidium*, *Tremellodendron*, *Hirneolina*, *Sebacina*, *Tulasnella*, *Septobasidium*, *Thelephora*, *Hypochnus*, *Coniophora*, *Hymenochaete*, *Mycobonia*, *Lachnocladium*, *Aleurodiscus*, *Stereum*, *Hypolyssus*, *Cladoderris*, *Asterostroma*, *Peniophora*, and *Corticium* (under *Ex-Thelephoreae*) and *Cora* and *Rhipidonema* (under *Hymeno-Lichens*). Burt is against sub-dividing *Peniophora* into *Gloeocystidium*, *Peniophorella*, *Gleopeniophora*, etc. He excludes the genera *Michenera* and *Heterobasidium* from the *Thelephoraceae*.

In the same year Lloyd[17] published his "Synopsis of the stipitate stereum" in which he divided the genus *Stereum* as Persoon did, firstly, into 3 classes, viz.-Stipitate, Sessile, and Resupinate or Sub-resupinate. He subsequently divided the stipitate species into eleven sections, the genus *Hymenochaete* as at present understood, being regarded as a section of the genus *Stereum*.

Rea[26] in 1922 includes under the order *Aphyllophorales* (sub-order *Porohydnineae*) the families, *Polyporaceae*, *Polystictaceae*, *Merulineae*, *Fistulinaceae*, *Hydnaceae*, *Thelephoraceae*, and *Cyphellaceae*. The *Thelephoraceae* contains the following genera :- *Sparassis*, *Stereum*, *Hymenochaete*, *Phylacteria*, *Cladoderris* *Epithele*, *Aleurodiscus*, *Corticium* with *Gloeocystidium* as sub-genus, *Cristella*, *Thelephora*, *Hypochnus*, *Tomentella*, *Hypochnella*, *Jaapia*, *Coniophora*, *Peniophora and Coniophorella*.

Killermann[15] in the Naturlichen Pflanzenfamilien (1928) divides the sub-series Hymenomycetineae into 7 families, one being the *Thelephoraceae* containing the tribes *Corticieae*, *Coniophoreae*, *Aleurodiscineae*, *Stereae*, *Thelephoreae*, *Craterelleae* and *Cyphelleae*. As many as twenty-four genera have been included and they are follows :—*Corticium*, *Peniophora*, *Gloeocystidium*, *Asterostroma*, *Epithele*, *Bonia*, *Wiesnerina*, *Coniophora*, *Coniophorella*, *Jaapia*, *Aleurodiscus*, *Cytidia*, *Asterostromella*, *Dendrothele*, *Stereum*, *Lloydella*, *Hymenochaete*, *Thelephora*, *Hypolyssus*, *Cladoderris*, *Craterellus*, *Skepperia*, *Cyphella* and *Solenia*.

The writer, however, regrets, that his present state of knowledge of the family Thelephoraceae as represented in Bengal is so incomplete and that it will be unwise to hazard a new system of classification at this stage. The classification suggested by Bourdot and Galzin in "Hymenomycetes de

France', (1927) seems to be a very complicated one and has been purposely eliminated here to avoid confusion.

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Determination of the Temperature of the Upper Atmosphere

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It was established long ago as a result of the classical experiments of Tyndall (*Proc. Roy. Soc. 30*, 19, 1879) on the measurement of the diathermancy of air that pure air is not an absorbent of radiant energy. Later on, after the wave nature of radiation was established, it was found that the permanent gases of the atmosphere are almost transparent to the infra red and the visible part of the spectrum. Thus the sun's rays in passing through the atmosphere cannot heat the intervening medium. There will, of course, be a slight rise in temperature due to absorption of radiation by aqueous vapour, carbon dioxide and the other impurities present in the air. This effect was negligible, however, and the general experience was that the temperature in region higher than the level ground was always less. Many experiments have been performed in the century, to test the real nature of the temperature of the atmosphere and its variation with height and the problem is still far from a definite solution. It is proposed to discuss the different methods employed and the experimental result obtained, in course of this article.

Experiments with Balloon--Manned and Un-manned

Leonardo da Vinci (1452-1519) is said to have planned to use the low density of warm air to cause balloons to rise, and he actually constructed flying machines and parachutes. The first ascent of a manned balloon was made in 1783 by the famous Montgolfier brothers, but the machine was rather crude, being filled with smoke. Balloon was perfected, however, after the discovery of hydrogen by Cavendish in 1766, and with such a balloon the French physicist, Gay Lussac, ascended to a height of 1½ miles in 1801 with a view to making observations on magnetism. With the perfection of the machine and the growth of scientific spirit these balloons came to be used as the means for getting the knowledge of the condition of the upper atmosphere. In this attempt a period of record-beating in ascent in height followed in course of the last five years, in which Piccard, Cosyns, Prokofiev amongst others took part. Many valuable lives were lost but many scientific informations were gathered by this method of exploration of the upper atmosphere. The lowest pressure record of 50 mm. (61,000 ft) for a manned balloon rests at present with "the Stratostat U. S. S. R." piloted by M. Prokofiev in September, 1933. A notice appeared however in *Nature*, June 22, 1935, that the preparation for a new ascent by the U. S. Stratosphere Balloon Explorer II (filled with helium) was complete and Stevens and Anderson would make the attempt. According to a later notice, however, (*Nature*, July 20, 1935) the balloon met with an accident and the flight was postponed. It may be mentioned here that the previous attempt with "Explorer I" met with misfortune in November, 1934.

The height attained in all these manned balloons, however, is rather small in comparison with the vast expanse that lies beyond. For an explorer to go even up to 10 miles, difficulties in many directions arise specially on account of the want of sufficient oxygen in the upper atmosphere. To push on with the exploration of the still higher regions 'sounding balloons' (Ballons sondé) were devised. These are the improvements on 'pilot balloons' used for recording the wind- velocity at various known heights. These generally carry a meteorograph which consists of a small aneroid barometer and a bimetallic thermometer enclosed together in a metal case for protection against the heat of the sun. The records are scratched on a strip of copper and finally read with the help of a microscope. In connection with this method, mention must be made of the work by Regeners (Erich Regener & Victor H. Regener). At present the record height attained by unmanned

balloons by E. Regener is about 28 km. at a pressure of 22 mm (*Nature, 133*, 204, 1934). The Upper Air Observatory at Agra records a height of 30 km. with a sounding balloon.

From pilot observation it was discovered in 1899 by Teisserenc de Bort and Assmann that earth is enfolded in two distinct layers of atmosphere. The lower layer is in immediate touch with the earth and extends from 6 miles in the polar regions to 10 miles at the equatorial regions of the earth. In this region, the temperature decreases with the distance fromthe earth's surface. Beyond this region, however, there is another region where the temperature is approximately constant although there are slight variations. No upper limit for the extension of that region could be given. Teisserenc de Bort gave the names "Tropo-sphere" and "Strato-sphere" respectively to the two regions. The transition layer between the two regions is a thin layer encircling the troposphere, and its name "tropopause" is due to Sir Napier Shaw. The height of this layer shows considerable variation varying from about 7 miles (in higher latitudes) to about 10½ miles (above the equator). It is possible, its lowest value will be obtained over the poles. In 1908 it was discovered by a German expedition to the Victoria Nyanza that the height of the tropopause there, was about 10½ miles and its temperature 190°K. At 11½ miles height (Stratostat U. S. S. R. 1933), the temperature recorded was 207°K (-88°F). During the last quarter of a century many data about the temperature of the upper atmosphere had been collected from observation in Batavia and India and also in the neighbourhood of Abisko in Lapland. It is now believed that over the tropics there is considerable increase of temperature above the tropopause, the average at 15 miles being about 220°K. Near the Arctic circle there is a wide annual variation of the temperature. Thus at a height of about 6½ miles, the range of temperature is from 212°K in January to 227°K in July. At 12½ miles the averages for these months are 207°K and 240°K respectively.

Experiments with Sound Waves as Explorer

It was a long known fact that sounds of big explosion could be heard at great distances, while at a certain distance nearer the origin, no sound was heard at all. The first explanation of the phenomena was given by the German scientist von den Borne. He inferred that, of the sound waves that were sent out in every direction round the site of an explosion, those travelling upwards proceeded with high acceleration for some distance and then at a certain height turned back to the earth again. As the waves travelling along the ground in a horizontal direction were after a time completely absorbed by the air molecules near the earth, the sound to distant places was carried by means of the upward waves only. Thus according to the above theory the sound will be heard with decreasing intensity up to a certain point beyond which there will be a belt-like region of inaudibility called the "zone of silence". Still farther away, however, there will be a region of audibility due to the reflected downward waves which will be followed by another zone of silence and again in some cases by a zone of audibility. No proper explanation of this alleged behaviour of the sound waves was obtained till the nature of the waves was fully established. This bending down of the upward wave can easily be seen from the consideration that if the temperature decreases upwards, the waves will also rise in a curved path that is concave downwards, on account of refraction, and if in its passage it comes to a region of uniform temperature the refraction will cease, and the waves will travel onwards in a straight line along their final direction. The region where this phenomenon happens is rather high up in the atmosphere where the air is in an attenuated state so that the wave in its straight path will not experience much absorption although it may travel through long distances. But the final bending down of the waves cannot be understood from the above arguments. This behaviour of the wave was clear from the researches in another direction.

In 1922 Lindemann and Dobson, the two English scientists, published a paper, "A theory of meteors and the density and temperature of the outer atmosphere to which it leads" in which they discussed the cause of the luminosity of those bodies. A meteor travels with a very great velocity in its flight and compresses very highly the air in its path. The air being thus heated raises the surface temperature of the meteor until it begins to

vaporize, when it becomes luminous and visible. The authors calculate the amount of air that must have been encountered before the meteor is raised to incandescence. As a result of such calculations they arrive at the conclusion that at heights where meteors are observed (about 60 miles), the density of the air must be very great and the temperature of air at heights of 35 miles and upwards is at least 300°K (about 80°F) *i. e.* near about our ground temperature. These conclusions have been confirmed by the experiments on

(1) vertical distribution of ozone with height;

(2) direct temperature measurements by balloon ascent, and lastly on

(3) the anomalous propagation of sound waves.

The probable high temperature at the level of about 35 miles above the ground gives the complete explanation of the bending down of the sound waves. Because at this level, the velocity of the sound waves travelling so far along a straight path on account of the constant temperature of the strato-sphere, will experience a sudden increase due to the increased temperature at that altitude and the waves would be turned back towards the earth passing as before along a straight path through the lower strato-sphere and then in a curve concave downwards through the tropo-sphere. These facts about the nature and behaviour of sound waves were ascertained before the great European war. They establish the fact that although the lower strato-sphere is more or less at a constant temperature, there is a rise in temperature in the upper atmosphere.

Fxperiments with Radio-waves as Explorer

Balfour Stewart, while investigating the variation of the earth's magnetic field, pointed out that there must be some layer of high electrical conductivity in the upper atmosphere. The possibility of some such region where continuous ionization was going on was also suggested later on by Olivier Heaviside. This layer is now known as the ionosphere, and its presence explains the circling of the radio-waves round the curved surface of the earth instead of vanishing in space. The free electrons of the ionized layer in the upper atmosphere cause an increase in the speed of the radio-waves and turn them back. In 1902 Kennelly and Heaviside insisted on the existence of such an ionized layer and the Kennelly-Heaviside layer is the name given to it when, in about 1922, its existence was experimentally demonstrated. With the advance of scientific research, the existence of many such ionized layers has come to our knowledge. At present we have indications for three ionizing layers in the upper atmosphere at three different levels, there being two distinct layers F and D above and below the Kennelly-Heaviside layer E, the upper one (F) being known also as the Appleton layer. This upper layer is subdivided into F_1, F_2 and the existence of another layer is suspected between the F and E layers. These ionized layers vary in height with the time of the day and the season of the year. The height of the lowest or the D layer varies between 25 to 30 miles. Longest radiowaves are reflected from it. The average height of the E layer is about 65 miles, it varying between 45 to 90 miles. It reflects waves between 300-400 metres in length. The height of the uppermost or F layer is subject to the greatest variations of all. Its average height appears to be 150 miles, it varying between 93 miles (Australia) to 250 miles (England in some October night). This layer reflects waves of about 100 metres in length. Still shorter waves will penetrate this layer and pass to the outer space.

The ionization and the liberation of free electrons in the ionized layers in the upper atmosphere may be caused by the bombardment of atoms and molecules by the solar radiation of ultra-violet and gamma type or by cosmic radiation. There are, however, variable layers of ionization which may originate from such agencies as meteors and meteoric matter, charged particles emitted by the sun, or thunderstorms. Taking every thing into account, we may still consider the highly penetrating solar radiation as the principal cause of ionization in the upper atmosphere. Now, from the theory of Photo-ionization by solar radiations, a ratio between the maximum ionization content in summer and in winter may be obtained and subjected to the experimental test for various stations. For the latitude of Great Britain it is found from experiments at different stations that the above ratio of the ionization contents for the E layer agrees closely with the theoretical value. Hence,

it is concluded that in Great Britain at a level of about 63 miles the density of air or the temperature is constant throughout the year. But for the upper F layer no such agreement with theory is obtained. It is surprising that for this layer the maximum ionization content for the summer noon is less than that for the winter noon. In a recent note in *Nature* (13th July, 1935), Appleton discussed this point and gave an explanation of this discrepancy which will considerably modify our idea of the temperature of the upper strato-sphere. Assuming that the distribution of molecular density in the atmosphere is constant throughout the year, it is found that the summer ionization is about 2 times the winter ionization and this is actually the case with the E layer. Thus from the experimental results for the F layer as outlined above, conclusion is inevitable that at that level the summer molecular density must be very low which indicates an increase of temperature. It follows from experimental results that at about 190 miles the temperature on a summer day should be 1200° K (about 1700° F).

Thus, taking into consideration the result obtained with the help of Lindemann and Dobson theory there must be an increase in temperature along the upper atmosphere also, its value at 35 miles being 300°K, and at 190 miles 1200°K.

To account for the cause of this temperature in the upper atmosphere various theories have been proposed. Thus we have the Balance theory of Gold in 1909 which attempted to explain the constant temperature of the atmosphere. According to that theory the constant temperature at any part of the atmosphere is determined mainly by the equilibrium of the radiation that is absorbed by matter in that portion and the radiation emitted by it. This theory is incomplete as it can not account for the sharp transition in the temperature gradient at the tropopause and also the contrast in the conditions over the equator and high latitudes. Lindemann and Dobson also showed that the high temperature in the upper atmosphere is due to the absorption of the ultra-violet radiation. However, from the experimental results, the fact emerges that although there is no indication of the absorption of the solar radiation by the lower atmosphere (troposphere) the same cannot be true of the upper atmosphere (strotosphere). That is to say, the upper atmosphere absorbs a portion of the radiation that passes through it and thereby gets heated to a temperature in some places which approximates to that of a pretty good furnace.

Report of the Geodetic Branch of the Survey of India—1934

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The Survey of India is the oldest scientific service in this country and was founded in 1818. The main office is situated at Dehra Dun, just under the foothills of the Himalayas. A second office and department for the manufacture of scientific instruments are located at Calcutta. This Service was originally created for making a systematic survey of the whole of India. In addition to this work, Tide-Tables are now prepared; and magnetic, meteorological, seismological and astronomical observations are also carried out. Survey maps for civil and military purposes are also prepared. The Service maintains a trained field party for touring the whole Indian Empire and making observations. The observations are then computed by a trained batch of computers at the main station. The labours of this Service have led to scientific results of the highest value. The most spectacular work of the Department was the discovery of the highest mountain peak in the world in 1845 which is now known as Mt. Everest. At the time of observation this peak did not at all look like the highest peak in the world from the station of observation, and nobody had even the remotest suspicion at the time that it would prove to be the highest peak in the world. When Mr. Radhanath Sikdar,* who was then the Head of the Computing Department at Dehra Dun, found by making actual computation that this was the highest peak in the world, his conclusion was first received with incredulity, but subsequent observations showed that he was right. Mt. Everest has not yet lost this position.

Less spectacular but more important for scientific purposes was the discovery made by Capt. Basevi that the value of gravity showed a defect over the whole of the Himalayan regions from the expected value. He was so much excited over the discovery that he did not leave his station on the Himalayas even on the advent of winter, with the result that his station became ice bound while he was engrossed in taking his observations, and rescuing parties found it impossible to cut their way to him. He thus fell a victim to his enthusiasm over this new discovery.* All glory to this martyr of Science! His work was continued and his results were confirmed not only over the Himalayan regions, but over all the high mountain ranges of the world. It is known now that these results led Archdeacon Pratt of Calcutta to formulate the hypothesis that the inequalities of mass over the surface of the earth are neutralized by opposite inequalities at an appreciable depth from the surface of the earth. Major C. E. Dutton coined the name 'isostasy' for this hypothesis in 1889. It is believed that the earth's crust underneath a mountain range is of lower density than elsewhere, whereas the crust below the deep ocean basins have got an excess of density. On the other hand at a moderate depth below the sea-level the density is everywhere very nearly the same. Moreover, the amount of matter in each of the vertical columns over equal areas of the earth's crust at such a depth is the same. The layer at this depth is called the "isostatic layer".

* For this discovery, Mr. Sikdar was presented with a copy of Laplace's *Mecanique Celeste* by General Everest, the Surveyor-General, during whose regime the observations were taken. The volume was till recently a valued possession of the family. It may be mentioned that Mr. Sikdar was picked up by Col. Everest from amongst the graduates of the Presidency College, was given special mathematical training, and placed at the head of the Computing Department. But for Col. Everest's intervention he would have become a Deputy-Collector. *Editor*—SCIENCE & CULTURE.

* The Basevi clock-tower at Dehra Dun was erected as a memorial to Capt. Basevi.

and its depth has been estimated to be about 120 km. below the sea-level. It means that the whole quantity of matter in a column per kilometre square to this depth is nearly the same whether the column consists of 120 kilometres of rock beneath a plane lying near the sea-level, or of 125 kilometres beneath a plateau, 5 kilometres high, or of 114 kilometres of rock beneath an ocean, 6 kilometres deep.

The "Theory of isostasy" is the chief scientific contribution of the Geodetic Branch of the Survey of India, of which it can justly be proud. The theory is generally true except at places of recent geological formation where the isostatic compensation is not yet complete. The Geodetic Branch of the Survey of India has also carried out a large amount of geodetic work in India and Burma. In order to determine the size and the shape of the earth, arcs of its meridians in different latitudes have to be measured by astronomical observations combined with geodetic operations. By astronomical measurements the distance between two selected stations can be obtained in circular measure of degrees, whereas by geodetic measurements it is possible to find out the exact linear distance between them in feet or metres. The radius of the earth regarded as a sphere can thus be approximately determined by dividing this linear distance by the angular distance measured in radians. The geodetic process by which linear distance is measured is known as *triangulation*. As it is not practicable to measure the linear distance between two stations directly with sufficient accuracy, other stations are also selected between the terminal ones. These intermediate stations are so chosen that the lines joining them form a complete chain of triangles, each station being visible from at least two others. The angles at each station and the length of the sides called the base, are measured with all possible precision. Knowing the length of the base and all the angles, it is possible to calculate every other line in the chain of triangles, and then to determine the exact north-and-south distance between two terminal stations. These measurements are done so accurately that the error hardly exceeds half an inch in ten miles. If the two stations are taken on the same terrestrial meridian the astronomical determination of the angular distance between them can be made very easily. In this case the angular distance will be the difference of latitude between the two stations. The latitudes are best determined by means of a zenith telescope.

The first authentic determination of the earth's circumference was made by Eratosthenes of Alexandria about 250 B.C. His two stations were Alexandria, and Syene (in upper Egypt) near about the Tropic of Cancer. At noon of the longest day in summer at Syene there was no shadow of the gnomon in the bottom of a well as the sun was vertically overhead. But, at Alexandria, on the noon of the same day, it was found from the length of the shadow cast by the gnomon that the angular distance of the sun from the zenith was 1/50th of the circumference of a circle (7° 15′). So the difference of latitude between Alexandria and Syene was in angular measure equal to 1/50 of the circumference of a circle. So the circumference of the earth must be 50 times the linear distance between these two stations. Eratosthenes stated that the distance between these two places was 5000 *stadia*. The stadium was 517 feet, and it is believed that the distance was probably measured in *paces* by specially trained men. The above calculation would give 24,500 miles for the earth's circumference, which is very near the truth. Similar operation for finding out the circumference of the earth was performed by Arabian scientists in the eighth century at Baghdad under the patronage of the Caliph al Mamun.

The first really scientific measure of an arc of the meridian was made by the Frenchman Picard in Northern France in 1671, and it was found out that the earth was not exactly a sphere but a spheriod, flattened at the poles.

For a complete programme of the work of triangulation it is necessary in the first instance to measure the base lines accurately. For the measurement of base lines invar wires * are used. These wires are standardized by means of 4-metre invar bars which, in their turn, are periodically compared with nickel and silica 1 metre standards. 4-metre invar bars as well as nickel and silica standards are kept carefully at a standard temperature at the Dehra Dun observatory.

* "Invar" is an alloy of nickel and steel whose coefficient of expansion is almost negligible.

The Survey of India has done much valuable work in connection with the tracing of the *geoid* by means of stations at close intervals.

The *geoid* is the sea-level surface from which the heights are measured. It is commonly believed that the earth is a spheroid flattened at the two poles, but actually our earth is not an exact spheriod. Due to irregularities, its surface is that of a distorted spheriod called the geoid. It is found that the geoid on the whole deviates slightly from a smooth spheriod, called the *International Spheroid.* But the observations of recent years in India and Burma reveal the fact that the resulting figure of the geoid at these places show remarkable departures from the curvature of the international spheroid. The radius of curvature of the geoid along an east-to-west section 2,500 miles long, in latitude 26°, is 700 feet greater than that of the international spheroid while the curvature of a 2000 mile meridianal section is 1,500 feet less than that of the spheriod. These irregularities can only be attributed to wide-spread departures from isostatic equilibrium. The geoid in the south of India is also deeply depressed and causes gravity anomaly there.

The Survey of India has also been carrying on extensive *levelling* operations in different parts of India. *Levelling* is the process of finding the differences in level between different parts on the surface of the earth by means of a levelling instrument, and thus the heights of stations above the surface of the geoid are found out.

Dehra Dun possesses a very interesting apparatus, designed by Lord Kelvin, called the *tide harmonizer.* By means of this apparatus tidal tables for the Indian Ocean are prepared.

We have received a copy of the report of the Geodetic Branch of the Survey of India for the year 1934. It is satisfactory to note that a large amount of geodetic work was carried out by this branch of the Survey of India during the year 1933-34. During the year under review three new base lines were measured and extended in Baluchistan, Poona, and Assam. In 1933-34, *levelling* operations were carried out in the areas disturbed by the Pegu Earthquake of 1930 and by the Great Bihar Earthquake of 1934. No notable changes were found in Pegu. In North Bihar and Bengal, levelling done in previous years has been showing a steady rise, but the Great Bihar Earthquake of 1934 appears to have caused a sudden fall. The reason for steady rise in past years can, perhaps, be easily understood. There is considerable underloading in North Bihar and North Bengal area, and Gruff-Hunter has suggested that the restoration of isostatic equilibrium is the cause for the steady rise in past years in the underloaded area of North Bihar. This area is filled to a great depth with alluvium of recent formation and of low density. There are two alternative theories for the depression caused by the earthquake. One theory is that the north-to-south pressure which has created the Himalayas and the associated over-thrust faults may still be acting, and that this horizontal force is responsible for occasional earthquakes which suddenly deepen the depression. On the other hand, the vertical forces are slow in their operation but act steadily in elevating the depression. The alternative theory is that the depression which resulted from the last earthquake may not have been directly connected with *tectonic* forces (forces causing movement in the Earth's crust, and thus giving rise to earthquakes), but may have been caused by consolidation of alluvium which was vigorously shaken. This view is supported by the great out-pouring of water and sand which occurred. During the year under review, important pendulum observations for checking values of gravity were made in the West Coast of India, Ceylon, Maldive Islands, and Laccadive Islands. In Ceylon, gravity data show a satisfactory agreement with the geology of the island. Presumably, tilted syncline which forms the main features of the geological structure of the island is not symmetrical. Perhaps it has been disturbed by the disturbance of a volcanic origin in the Adam's Peak region. In the Maldives, gravity data support the subsidence theory of the formation of coral islands. The Maldive Islands overlie an area where a block of *sial* has subsided as a result of the downwarping of the lower crustal layers. Gravity results reveal that the Laccadive Islands are tectonically (*i. e.* as regards crust formation) different from the Maldive Islands. Gravity anomalies in Southern India can be explained by supposing that the extreme south has been squeezed down between a few upwarps.

During the year under review Tidal Tables for 1935 for the Indian Ocean were also prepared.

The Democratic Process

The Democratic Process—*by Dr. Beni Prasad, Humphrey Milford: Oxford University Press, Price Rs. 7/-*

The author of the book is well known to scholars in India as well as England as a student of a branch of social science which, apart from its high scientific quality, is of immense practical value in the age in which we live. This branch of social science has under the name of Political Science made a remarkable progress, specially in recent years, due to the efforts of a distinguished and devoted band of scholars in Europe and America. Today it possesses a literature which is staggering in its vastness. Only special aspects of the subject can be studied by any one scholar who is at all anxious to be thorough and scientific.

An aspect of Political Science which is of supreme interest to the present generation is 'Democracy'. Indeed modern Political Science is the science of the Democratic State which by its diffusion of actual political power to every adult citizen has created institutions and problems, sometimes baffling in their intricacy—certainly a fit subject for specialized scientific study. The value of such a study lies in the formation of correct judgments about the worth of democratic institutions and formulation of principles for the guidance of the statesman and the politician. Besides every free citizen today is concerned with the nature of the political machine in the Democratic State which controls and regulates his life. An enormous expansion in the field of government in such a state has brought politics to the door of every Tom, Dick, and Harry. A study of democratic political institutions, problems, and processes by competent scholars cannot but be welcome. Dr. Beni Prasad's book studying as it does the 'democratic process' which has given birth to the modern science of Politics is very welcome.

In the long and distinguished roll of writers on Political Science as it has developed in the West, the name of any Indian has been practically conspicuous by its absence. We are sure that Dr. Beni Prasad by his present work will figure prominently in that roll as the first Indian writer of a thought-provoking book on political science.

The book has been published at a psychological moment when our old ideas of political and social values are undergoing a revision. For some time past there has been a feeling among a growing number of people that parliamentary democracies have outlived their usefulness. There has been an impressive reaction against democratic forms of government in Europe. But Dr. Beni Prasad has evidently not lost his faith in the value of democracy which he thinks to be the logical outcome of a long process of social evolution.

Dr. Beni Prasad studies democracy in its philosophical and institutional aspects. This of course has been done by numerous scholars before him and at the present day the output of literature on democracy does great credit to the capacity of our writers and thinkers. Dr. Beni Prasad however strikes an original note from the very outset. He bases his study on what is in effect an analysis of human nature which, in the words of Lord Bryce, is the "basic and ever present element in the endless flux of social and political phenomena, which enables general principles to be determined". Human nature is responsible ultimately for our social and political behaviour. The author is however not content with this alone. At every step he tries to discover the relationship between human, social and political, behaviour and behaviour among lower order of animals, with examples taken from the science of biology. The attempt to rest democracy on psychological and biological foundation is obviously interesting. It is bound to provoke thought and stimulate discussion.

Dr. Beni Prasad states his thesis thus :—"No ultimate goal can be prescribed for human life...... The rôle of social philosopher is not to lay down immutable ideals for all time. It is enough to dis-

cover conditions favourable to the development and expression of personality". Self-realization is the end of the state. The conditions favourable to it are (a) progressive social organization which would make change possible whenever desired ; (b) opportunities for continuous initiative in society which alone is liberty ; (c) the right to congenial work which alone is one of the basic conditions of good life ; and (d) leisure which would call the best faculties of the individual into play. "To the extent that material welfare, liberty, creativeness, and leisure are secured and aspiration opened not to a few but to the mass of people under all skies can democracy in the deeper sense of the term be said to be achieved. The democratic process thus consists in the development of human personality everywhere in all climes (p. 24). And if such a comprehensive view which alone can claim to be a philosophical view is taken democracy appears to be as yet an aspiration rather than a reality".

Ignorance, error, unequal distribution of wealth and culture, domination of one class over another are factors that have served as obstacles to the realization of good life. Some of these factors like wealth and culture and social gradations have also served both as an obstacle and as a stimulus to human development, The good that has resulted from the state is attributable largely to 'organization'. But there are great risks in organization which must not result in the 'smothering of personality'; (chap. III and IV). There is another great obstacle to human development and that is the 'inertia of accomodation which sanctified by the accepted 'mores' and buttressed by theology, fatalism, and pessimism offered tenacious resistance to the inception or continuation of reform' (chap. V. p. 59). But at last the corner is turned. As knowledge grows from more to more, as education and enlightenment spread, conditions are created under which all can find scope for development, and "democracy, in the deeper and ethical sense, can be translated into fact". (chap. VI).

In the next three chapters the author reviews the problems of production, population, and man versus machine. He opines that there is no danger of over-population in the world for a long time to come. Tendencies are towards keeping population well within manageable limits. He is apparently a believer in modern methods of family limitation, and concludes that 'the application of science to agriculture, industry, and transport all over the world is a condition precedent to the realization of universal democracy'. Besides, "every country must plan its economic life and co-ordinate its plans with those of other countries in the general interest of humanity (p. 92). Along these lines it is *possible* to lay the economic foundations of democracy by utilizing the sources of science and technique".

But there are certain obstacles to co-operation *viz*. militarism, race and colour prejudices, political and economic nationalism, imperialism and imperfections in the existing internal organization. Militarism is not reconcilable with the spirit of democracy which rules out force. Imperialism has to be abandoned as withholding the right of self-realization from the subject nations, and political and economic nationalism must make room for internationalism. The author realizes that tangles of centuries cannot be resolved in a moment, but a beginning must be made at once.

The author is confident that 'international co-operation founded on principles of universal peace and universal well-being is calculated to promote the normal and economic conditions favourable to democracy' (p. 183). Democracy cannot flourish in the midst of poverty which can only be banished by planned economy based on an international co-ordination of economic efforts. "Planning would represent a concerted effort to accelerate the democratic process". (p. 211).

In chapter XV, the author reviews the problem of social control in the light of the new developments. After referring to the rise of political pluralism which looks upon the state as a union of associations and groups, each with its own corporate life and importance for the welfare of society as a whole, he points out that in the new phase of development social control is likely to be greater than ever before. But social control must have a vital regard for personality, an object which can be achieved by two means, the infusion of social control with science and its democratization. *Advisory committees and chambers including trained experts*

can be associated with all legislatures and administrative departments in international, national, and local governments to supply up to date knowledge, to conduct investigations in a scientific manner and think out plans" (p. 223). "Next in importance stands the need of democratizing the institutions which is likely to place vast resources of intellectual and moral power at the disposal of social and political institutions and make them responsible to all the needs and interests of the community" (p. 225). The author concludes on a note of optimism, "The democratic principle has never yet had a fair chance in politics because of militarism, general poverty, and ignorance, and difficulties of communication. Now that it is possible for the world to outgrow these obstacles, it is also possible in the same proportion to bring genuine democracy into being on a large scale". (p. 225).

In chapter XVI, the author examines the case against democracy and finds that in ultimate analysis the case against democracy rests on the assumption of innate incapacity of the mass of the people to exercise the intelligence and organization which government demands. He does not agree and puts the case for democracy emphatically as follows, 'Under present conditions no better alternative is open to mankind.... It is, as a rule, the most appropriate form of government in modern times. It came into vogue when governments had become more complicated.... It is informative. It admits the will of all members into the determination of s polity ..... It taps sources of political talent, which lie beyond the power of other systems of government. It favours a wholesome social equilibrium. It deepens the sense of social obligation. (p. 213).

The last three chapters of the book deal with th machinery of the democratic state, public opinion, and transformation. The world has to be transformed and reconstructed by social service with the aid of our economic and cultural resources now vastly augmented. It is only then that democracy which is now an aspiration will become a reality.

A distinguishing feature of the book is its tone of idealism and robust optimism. The writer appears to be undaunted by the depressing events of the last fifteen years. The flight from representative democracy in a greater part of modern Europe is apparently dismissed as a passing phase which cannot permanently arrest the irresistible march of democracy. It is here that our clear perception of his reasoning becomes somewhat obscured by a passing cloud of misgivings. We begin to ask whether he does not rely too much on the latent possibilities of the homo sapiens ? Dr. Beni Prasad admits that democracy is now an aspiration and not a reality. For the realization of the aspiration, ignorance must be removed, poverty must be banished, militarism must be banned, colour prejudice must be eliminated and political and economic nationalism must be replaced by international cooperation. The resources placed at our disposal by science must also be fully utilized. There must be planning of the economic life by governments in consultation with one another. All this ambitious programme implies a sustained rational endeavour, and sentiments cannot be allowed to play their part. Besides, are the institutions of democracy, *viz*. parliaments, cabinets, parties, electorate, capable of achieving this programme ? Modern dictatorships seem to afford a negative answer. For the time being democracy has lost its emotional appeal as well. Can it achieve big things ? That is the question wich is agitating the minds of nations. Can it put an end to class struggle ? Then again, in the modern state the administrative expert is assuming an importance which bids fair to make parliaments nothing better than debating assemblies and voting automatons. They have already become so.

These arguments against democracy, however, do not detract the importance of the work under review. Its value lies in showing the democratic purpose in a long process of social evolution and as such it is bound to hold an important place in political literature for a long time to come. The style of the book is lucid and vigorous. We congratulate the author on his fine achievement.

G. S. C.

Book Review

Central Asian Antiquities Museum, New Delhi: Descriptive Catalogue of Antiquities recovered by Sir Aurel Stein during his explorations in Central Asia, Kansu and Eastern Iran—*By Fred. H. Andrews. Delhi, Manager of Publications, Government of India. 1935. Price Rupees Six or 9s. 9d. Pp. x + 445. Three illustrations and a map.*

The history of Central Asia has not yet been fully worked out. The physical difficulties of this inhospitable land, the paucity of historical material, the diversity of the tribes with varying degrees of culture have combined to make the task of the historian difficult but have at the same time added to it a peculiar charm. The physical features of the region have never been favourable for the growth of unified kingdom. Consistent with the diversity of its history, Central Asia has had many languages, scripts and religions. The languages used in the discovered manuscripts number about two dozens, including Indian, Chinese, Turkish, Tibetan, Iranian, Sogdian, Syriac and Uigur. Philologists have succeeded in establishing the existence of two entirely new languages. The first has been called Nordarisch by Leumann and Saka by Lueders and Konow; it is an Iranian language with some Indian idioms, and is held to have been the language of the Kushans. The second is called Tokharian or more properly Kuchanese with two dialects; it is definitely an Indo-European language and belongs to the *centum* group. Brahmi, Kharoshthi, Chinese and some undeciphered scripts were used in writing. Buddhist, Manichaean and Christian edifices, *Stupas* and caves are found here side by side. Zoroastrianism, Nestorianism and Taoism, perhaps not always exclusive of one another, also flourished here.

Buddhism has been the best means for the propagation of Indian culture to foreign lands; and the history of Buddhism in Central Asia is a glorious chapter in the history of Greater India. According to Tibetan tradition Buddhism reached Khotan in the first century before Christ, and we have sure indications that by the second century A. D. it was fully established in the land. According to Hiuen Tsang, it was introduced by an Arhat from Kashmir who succeeded in converting the king. That Buddhism found its way into Central Asia from the north-west of India further appears from the fact that the Chinese pilgrims found the Sarvastivada flourishing in Central Asia more than any other sect; we should remember that Sarvastivada had its palmy days in the north-west at the time of Kanishka's council and that Asvaghosha who has been actually called a Sarvastivadin in a Tibetan manuscript (*Journal of the Bihar and Orissa Research Society*, 1935, p. 28, n. i) is said to have taken a leading part in that council.

The Indian literature discovered in Central Asia is of great historical importance. The oldest palm-leaf manuscripts written in Indian characters come from Central Asia and consist of dramas, poems, Buddhist scriptures, and medical treatises. A Sanskrit drama in this collection, the *Sariputra-prakarana*, is the oldest sure specimen of Indian dramatic art. From the available fragments it seems that the Buddhist texts of this land formed the original of the Chinese *Tripitaka*. Unlike their co-religionists in China, Japan, and Tibet, the Buddhists of Central Asia seem to have used an Indian version of the *Tripitaka* and not a native translation.

The successive tours of Rockhill, Bower, Younghusband, Sven Hedin, and other intrepid travellers have thrown great light on the anthropo.ogy, climatic conditions, history and topopraphy of Central Asia. But the most well-known of these travellers is Sir Aurel Stein who conducted three successive tours in these difficult regions, all productive of excellent results. He has proved that in ancient times the climatic and physical conditions of the country were very different; deserts which are now incapable of sustaining any life had not only been the habitat of people, but also, in some cases, the seats of learning and culture, inasmuch as he found there statues, frescoes, and even rich libraries buried in the sand. His tours have been equally rich in results from an

anthropological point of view. The design and weaving of textiles of silk, cotton, and wool, discovered by him reveal entirely new facts about the migration of art and crafts. The similarity of the pottery found in Central Asia, Baluchistan, Persia, and Iraq has an important bearing on the diffusion of culture. And another relic of unique interest is a type of cornelian beads, the like of which are also found in Iraq, Baluchistan, Sind (Mohenjo-daro), western Siberia, and other seemingly detached places. Sir Aurel has also succeeded in locating many places mentioned by the historians of Alexander, Fa Hien and Hiuen Tsang and in discovering the old routes connecting Kashmir, Central Asia, and China.

Sir Aurel found numerous Buddhist images, carvings in wood, and paintings, in which the influence of the Graeco-Buddhist art of Gandhara is palpable. In the history of Gandhara art this fact is of great import and leads us to believe that, as the art of Gandhara flourished most in the reign of the Kushans, Buddhist art was introduced in Central Asia during the era of Kushan supremacy in north-western India. In the province of Seistan in eastern Iran there is a monastery with paintings of the Hellenistic type, which show 'for the first time *in situ* the Iranian link of the chain which connects the Graeco-Buddhist art of the extreme north-west India with the Buddhist art of central Asia and the Far East.

The antiquities discovered by Sir Aurel form a mass of raw material to be taken into use by subsequent workers in the field. They have been deposited in the Central Asian Antiquities Museum, New Delhi, specially built to receive them. Mr. Fred J. Andrews has now furnished us with a detailed catalogue of the same. He has done his work entirely satisfactorily, and his introductory pages are particularly interesting and valuable for getting an idea of the relics recovered by Sir Aurel.

A catalogue of this type should have contained many more illustrations.

A. Ghosh.

Lac and Indian Lac Research Institute, Nankum, Ranchi—The Annual report, 1934.

Lac dye and shellac are the product of the insect laccifer lacca, Kerr. India had the monopoly of the day. This has now been completely ousted from the market by coaltar dyes. The byeproduct shellac has now become the main product for many years but this is also meeting serious competition from synthetic resins like bakelite etc. No precautions were taken before to improve the quality of shellac and nothing had been done to stop its deterioration which invariable occurs on storage. The serious competition from outside induced the Government of India to start the Lac Research Institute at Nankum after a thorough preliminary enquiry. The object of the Institute has been the following :

(a) To study the various host plants.

(b) To make entomological survey of the lac producing insects.

(c) To improve the methods of manufacture.

(d) To improve the yield of stick lac by removing other pests and by adopting other means.

(e) To study suitable soil for the growth of the host plants.

(f) To devise processes which may stop deterioration.

(g) To prepare plastics from deteriorated samples,

These activities have been well described in the "Lac and Indian Lac Research Institute" by Dr. Norris and her collaborators. On the chemical side, excepting Harries, Nagel and Gardener, there are very few workers. It appears that the chemistry of shellac is not engaging much attention in the Research Institute at Nankum, but the entomological, agricultural activities, standardization and search for new plastics with shellac as base are extremely laudable. Extensive bibliography is given by which the reader will be able to grasp the progress of the Institute since the foundation.

M. Goswami.

The Carnegie Institution of Washington

Review of the work for 1934

The Carnegie Institution of Washington possesses a capital of about 31 million dollars and in the year under review one and a half million dollars were spent as follows : -

		Expenditure in lakhs of dollars
1.	Mount Wilson Solar Observatory Pasadena, California	2'39
2.	Department of Terrestrial Magnetism Washington D. C.	1'82
3.	Nutrition Laboratory Boston, Mass.	'19
4.	Department of Meridian Astrometry Albany, New York	'25
5.	Geophysical Laboratory Washington D. C.	1'67
6.	Department of Genetics Long Island, N. Y.	1'41
7.	Department of Embryology Baltimore	'75
8.	Division of Plant Biology Palo Atto, California	1'10
9.	Tortugas Laboratory Florida	'14
10.	Division of Historical Research Washington D. C.	1'60
	Subsidiary grants	1'24
	Publications	'69
	Administration & Miscellaneous	'68
	Reserve fund etc.	4'60
	Total (lakhs of dollars)	18'83

Besides these grants which were given from the income of the Carnegie Institution of Washington, the resources of each laboratory were supplemented by grant from the Carnegie Corporation of N. Y. for special purposes.

The Mount Wilson Solar observatory

This is at present probably the greatest astrophysical observatory of the world. Founded in 1903, with funds provided by Mr. Carnegie, its activities have expanded enormously in recent years. It contains the famous 100-inch reflecting telescope with which the farthest depths of space are being at present explored. The observatory aims not only in making a minute physical study of the sun, the stars, and other heavenly bodies, but also interpreting them from the point of view of physics. A physical laboratory is therefore attached to it under the superintendence of Dr. King, who vaporizes elements in a high temperature furnace and studies their spectra. One of the most unique features of this organization is the institution of research associateship. It enables distinguished professors and workers from other universities and observatories of America and Europe to come to Mount Wilson and spend a part of their time there. The Mount Wilson Observatory has thus become the Mecca of all physicists and astrophysicists.

The contributions from this observatory are too numerous to be mentioned, and reference can be made only to a few outstanding ones. The reader must have heard of the present theory of expanding universe, which arose out of Einstein's theory of Relativity. According to this theory, the universe is expanding,— at a rate which is proportional to the distance of the mass from the observer. This extraordinary result was deduced from Einstein's equations by Le Maitre, a Belgian astronomer in 1927. He calculated that the rate of expansion is 560 Km for an object at a distance of 1 million light years (one light-year means the distance travelled by light in one million years.) It was impossible for any other observatories excepting Mount Wilson to put this theory to test. They took the photograph of a large number of extragalactic nebulae, (*i. e.* clusters of star lying outside the

galaxy or the milky way, and therefore at a great distance from us) and verified the law. This year they found that two of the nebulae were receding from us with the extraordinary velocities of 24,000 and 10,000 Km per sec. respectively. Drs. Hubble and Humason, who have engaged themselves in this problem for a long time have found that the velocity-distance relationship holds for nebular clusters as well as for isolated nebulae.

Investigations of Planetary Atmospheres

Though the planets are the heavenly bodies which are nearest to us, we do not have much knowledge of the physical constitutions of them, because they only shine by the reflected rays of the sun. Hence their investigation has been very difficult. Owing chiefly to the work carried out at Mt. Wilson and also at the Lowel observatory (Arizona), it has been found that the atmospheres of big planets like Jupiter and Saturn contain NH_3 and CH_4. Smaller planets like Mars and Venus do not appear to contain any H_2 and very little of O_2. The solar research in the year under review comprised researches on Sun-spots, their magnetic behaviours, and photographing the infra red part of their spectra by means of new sensitizing dyes discovered by the Eastman Kodak Company. Many surprising results have been found, as for example, the discovery of sulphur and phosphorus, amongst the solar elements, the discovery of absorption lines due to helium and ionized helium.

It is known that the spectrum of the Sun contains some features which have not yet been explained. For example, during total solar eclipses, lines are found in the spectrum of the solar corona, which have not yet been identified with that of any element found on the earth. One such line is the green coronal line 5303. Its origin is still a puzzle, because it has not been so far found in any terrestrial or celestial sources. But last year Dr. Adams, director of the Observatory was able to identify these lines in a new star which had suddenly flashed out (Nova). This brings the solution of the problem nearer home.

The founder director Dr. G. E. Hale, retired some years ago but still lives in the observatory as Director-Emeritus. He is now devoting his spare time for the supervision of the plans for the 200″ telescope which is being now completed by funds supplied by the Carnegie Corporation of N. Y. The present director, Dr. W. S. Adams, not only carries on the administration, but also his research work on stellar photometry.

The Department of Terrestrial Magnetism at Washington was originally founded for a detailed study of the Earth considered as a magnet, but it has rapidly extended its activities, and is now examining the entire field of magnetic and electrical phenomena of the earth and its atmosphere. But these problems cannot be solved unless the basic problems of magnetism as a phenomenon of atomic structure are understood. The department has thus been steadily expanding its activities.

The central laboratory is situated in Washington D.C. This enables it to be in close co-operation with government departments and other scientific institutions of the country. The magnetic survey of the earth is undertaken on a systematic basis in co-operation with many other institutions and sub-stations. Since 1925, the department has organized a programme of research on Ionosphere at Washington, Huancayo (Peru), and at Watheroo (West Australia). In the discussion on Ionosphere which we publish in this volume of SCIENCE & CULTURE the problems of Ionosphere have been thoroughly explained. The stations have been chosen by the Carnegie Institution on the principle that one should be in the equatorial region, one in the Northern Hemisphere (Washington), and the other in the Southern Hemisphere (Watheroo), West Australia. They are thus enabled to get a striking confirmation of the theory that radio waves split up in the magnetic field of the earth, and the frequency difference is proportional to the earth's field. Thus the frequency difference between London and Huancayo is in the ratio of five to three. At Washington, a method has been perfected by Gilliland for continuous and automatic recording of the ionosphere height.

In the atomic physics section, the laboratory has been provided with an electrostatic generator yielding two million volts. With the aid of this generator experiments were performed on the disintegration of nuclei by means of protons and deutons. One of the most remarkable achievements of the depart-

ment is the discovery of triple hydrogen nucleus. which is found as an impurity in deuton (heavy hydrogen). Other activities of the department include the investigations of the solar activity, the magnetic activity of the earth, the registration of magnetic storms, the investigation of the electrical state of the lower atmosphere, and the measurement of the earth current. Magnetic survey of ocean is carried on by the steam ship *Carnegie* which is made of magnetic material. The *Carnegie* also contains a marine biological laboratory as well as a laboratory for physical and chemical oceanography.

The Geophysical Laboratory, Wshington D. C.

The object of the Geophysical Laboratory (it might better be called the Geochemical Laboratory) is stated to be "the study of the physical conditions of the Earth. These investigations have concerned both the past ages of the earth's development, and the conditions obtaining today within the earth upon which we live". The laboratory has a unique experimental equipment of studying the properties of bodies under high pressure and high temperature, such as is supposed to occur inside the earth's crust. They are carrying on the systematic investigation of the conditions under which artificial and natural minerals crystallize from molten silicate solutions. Pressures as high as ten thousand atmospheres have been used. The knowledge obtained from these studies have been utilized in the manufacture of precious gems, and may throw light as to how carbon crystallizes to diamond.

Other attendant subjects of study are,

(1) Volcanology: study of the processes noted in connection with eruptions from volcanoes and other igneous eruptions.

The Laboratory maintains a station at Mount Katmai in the Hawaii Islands. This is an active volcano in the midst of a valley which is known as the *valley of ten thousand smokes* on account of the existence of numerous fissures and vents from which steam and gases of different kinds are being ejected. The results obtained from these studies throw much light on the constitution of the earth's interior.

(2) Seismological Laboratory:

The Department also maintains a seismological laboratory for the study of earthquakes. Work in this laboratory is carried on in co-operation with the Advisory Committee on Seismology of the Carnegie Institution and with the Division of Geodesy of of the U. S. coast and Geodetic Survey, and other numerous societies interested in the earthquake problem. The laboratory maintains several automatically recording seismographs, which are manufactured in its own workshop, and keeps earthquake records as part of the routine work. A large number of workers is employed in interpreting the seismograms. From time to time, the workers pay visit to the earthquake stricken areas to gain first hand information of a disaster. The laboratory also carries out researches for study of direct relation of earthquake vibration to engineering structures.

The department has also rendered valuable help in the planning of the 200 inch telescope.

(to be continued).

Report of the Kaiser Wilhelm Gesellschaft

The K. W. I. for Plant-Breeding Research Munchenberg (Marr)

K. N. Bahl

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(Continued from September issue)

This institute is under the direction of Dr. Bernhard Husfeld and carries on researches in plant-breeding with a view to improve the yield of crops. During the year the scope of the institute has been extended and many additions have been made to the staff. Special laboratories have been built for research on potatoes and vine. On account of its economic importance, researches on *Lupinus* (hops) have received a great deal of attention from workers in this institute. Work has also been carried out on wheat, tobacco, and potatoes. The present movement in Germany for making the country independent in the supply of raw materials and food supply is strikingly reflected in the large amount of work on the diseases, modes of propagation, and profitable cultivation of a large variety of useful crops.

The total number of workers in the institute is 33.

The K.W.I. for Entomological Research, Berlin—Dahlem

This institute has been presided over by Dr. Walter Horn for the last 25 years, and it has produced valuable work in entomology. During the year the total number of workers who took advantage of the facilities provided by the institute was 210. The institute lent out 32,000 specimens to 125 different workers in 19 different countries.

K.W.I. for Hydrobiology, Ploen (Holstein)

Dr. August Thienemann is the director of this institute which was started by Dr. Utermöhl at Plön. The Plön lake is one of the most completely surveyed lakes in Germany and so far 3,000 deep soundings and 11,000 coastal soundings have been taken and 7 islands surveyed.

A large number of inquiries were made by the fisheries, trade sailors, and factories for advice regarding the use of water for technical purposes. The Government of North Brazil requisitioned the service of one of the members of the institute, Dr. Lenz, for advice in connection with fisheries and limnology.

It is worth noting that some of the work in the institute was carried out by unemployed scientific workers with the financial assistance of the Government and the unemployment insurance funds.

Biological Station in Lunz (Austria)

This institute, which is presided over by Dr. Franz Ruttner, was taken over by the K. W. Society in 1924 and has been conducted in co-operation with the Academy of Sciences of Vienna. A three-week course in hydrobiology was attended by 55 workers. Work in connection with the materials of the German limnological Sunda-Expedition was continued and biological surveys of moors were undertaken.

German-Italian Institute for Mraine Biology (Rovigno d'Istria)

The institute is managed by Doctor Adolf Stener and Dr. Massino Sella. Twenty-five workers took advantage of the facilities offered. The important work carried out by the institute is the preparation of a monograph on the Teredinidae, a group of molluscan ship-worms which were the cause of the famous dam-break in Holland at the beginning of the eighteenth century.

Ornithological Observatory (Rossitten).

The local director of this observatory is Dr. Johannes Thienemann who works under the guidance of Dr. Oskar Heinroth of Berlin. The institute is arranged for a short course on Ornithology during the year and all those who attend the course become active helpers in the work of the institute. As a part of the International Congress scheme, a census of white storks was taken in East Prussia in 1931. A monograph on white storks was also issued in 1931. Attempts were made to "plant" storks in localities where they were rare from places where they were very numerous.

The "ringing" of birds was continued and as many as 95,000 birds were marked with Rossitten-rings.

The K. W. I. for Anthropology, Human Heredity and Eugenics (Berlin-Dahlem)

This institute is under the directorship of Dr. Eugen Fisher and has shown remarkable activity. It gave a course of instruction in Eugenics to medical men, priests, teachers, lawyers and others. The director and his staff have also given course of lectures at various other institutions. The work of the institute has been deeply influenced by the political developments in the country and the institute has placed its services unreservedly at the disposal of Government in public interest. Several papers on social hygiene, sterilization, racial heredity, physical and social anthropology were contributed by the staff during the year.

The K. W. I. for Micro-biology Sao Paulo (Brazil)

The director of the institute is Dr. Martin Ficker. The important work on leprosy is being continued. In 1932, human leprosy was successfully transmitted to a white rat. This experiment was repeated a second time during the year and the tumour in the white rat appeared after a period of 1 year, 5 months, and 8 days. In man, cases are known in which the period of incubation has been 20 years. Sections of rats showed infection of the kidneys, heart, lungs, and inguinal glands.

A New Theory of Elementary Particles

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The uncertain and mysterious character of "material waves" in Wave Mechanics which are assumed to be somehow associated with elementary particles like electrons, protons, etc. has evoked much criticism recently. There is a marked tendency in this branch of theoretical physics to dissociate itself from any visual picture and to concentrate on mere mathematical symbols representing certain phenomena which are regarded as manifestations of these elementary particles. In a recent paper in *Physical Review* (May 1935), Einstein, Podolsky, and Rosen pointed out the incomplete nature of the description of reality as given by a wave function. They maintain that for a complete theory it is necessary that every element of the physical reality should have a counterpart in the physical theory and that the wave function lacks this property. In an interesting paper on "A Theory of Elementary Particles" in the *Philosophical Magazine* (September, 1935), Dr. Japolsky (formerly of Technological Institute, Leningrad) criticizes the unreal character of the wave function and emphasizes the point that a picture built on macroscopic model would be for us more vivid and tangible than an abstract representation built on a system of mathematical symbols, however accurate and elegant it may be. He constructed models of elementary particles in the form of macroscopic systems of rotating cylindrical electromagnetic waves in free space. In this system, the "electric charge and the "material waves" are not separate entities and may be regarded as some convenient manifestations of certain types of electromagnetic waves. The author calls these waves "Electro-magnetic Whirls". He applies methods of classical electrodynamics only to obtain his results. On the basis of this classical method he has shown that in order that the "electromagnetic whirls" may be stable they must satisfy the postulates of the Theory of Relativity and Quantum Mechanics. They should also satisfy the de Broglie relationship between the velocity of a particle and the speed of propagation of phase of its waves.

The author finds that if u is the speed of propagation of the phase along the axis of cylindrical wave, which may in short be called the axial speed of propagation, and v is the axial speed of a *wave train* then $uv = c^2$, where c is the speed of light. This is analogous to the well known de Broglie formula for a material wave. In the author's notation $\beta = 1/\sqrt{1-c^2/u^2}$ which is clearly equivalent to $1/\sqrt{1-v^2/c^2}$. This is now seen to be the well known coefficient in the Lorentz-Einstein transformation. The author also obtains the formula $\lambda = c^2/\beta\nu_0 v$, where λ is the wave length and ν_0 is the frequency of the wave train at rest. This is analogous to de Broglie formula for the wave length of a "material wave" *viz.* $\lambda = h/m_0\beta v$ where h is the Planck's constant and m_0 is the rest mass. If we put $m_0c^2 = h\nu_0$ the two forms are seen to be identical. It may be mentioned here that if we put Japolsky's formula in the form $\lambda = h/m_0\beta v$ then h is the constant only for a given "whirl" and not the universal constant. The author also calculated the total energy and the angular momentum of a "*whirl*". The "whirl" also possesses a definite inertia, i. e., it requires energy to acquire speed. Whatever may be the mechanism producing this inertia, in accordance with classical dynamics, it may be measured by the "*mass*" in the case of translatory motion and by the "moment of inertia" in the case of rotatory motion. In fact we may define "mass" and "moment of inertia" in terms of inertia. Defining "mass" as above, the author found that (1) when the direction of acceleration coincides with the direction of speed then $m_l = \beta^3 m_0$ where m_l is called the "longitudinal mass", and that (2) when the direction of acceleration is perpendicular to that of the speed then $m_t = \beta m_0$ where m_t is called the "transverse

mass". Here $m_0 = \frac{E_0}{c^2} = \frac{E}{\beta c^2}$ where E is the total energy of the whirl, m_0 may be called the "invariant mass" or "stationary mass" i.e. the mass when $\beta = 1$. E_0 is the intrinsic energy i.e., it is the value of E when $\beta = 1$. These are similar to the well-known relativistic formulae for the mass.

In order that the expressions for the phase and the total energy of the whirl may remain invariant both for the translatory as well as the rotatory motion, when the space co-ordinates x, r, θ, and the time co-ordinate t are changed respectively into the co-ordinates ξ, ϱ, θ, t_1 the author found that the following relations should hold good: –

$$\xi = \beta q_0 \, | x | , \qquad \varrho = \zeta_0 \, r,$$

$$t_1 = q_0 \left(\frac{t}{\beta} - \frac{v \xi}{c^2} \right),$$

where q_0 is a certain constant. Here origin of x is taken in the moving central plane of the whirl If it is referred to a fixed origin then we have to substitute $x - vt$ instead of x. We now see that, in the special case when $q_0 = 1$, the forms become equivalent to the well known Lorentz-Einstein transformation in the special theory of relativity. It is yet to be seen whether by giving suitable values to the constant q_0 results of the general theory of relativity can be deduced from Japolsky's formulae. It should be clearly understood that Japolsky's results satisfy the principle of relativity not as a postulate but as a corollary. On Japolsky's hypothesis the principle of relativity can only be valid in the universe as a result of its electromagnetic structure.

If v_x is the axial speed and v_z is the lateral speed of the "whirls" then law of addition of velocities is found to be $v^2 = v_x^2 + v_z^2 - v^2 v_z^2 / c^2$ This formula is also obtained strictly on the basis of classical electrodynamics. For any fixed observer the axes of v_x and v_z must also rotate, consequently the usual formula $v = \sqrt{v_x^2 + v_z^2}$ will not be applicable. Among the "whirls", two categories can be distinguished depending on the relationship between the electric and magnetic vectors, and the author has classified them as "electropolarized" and "magnetopolarized". If two "whirls" are polarized in the same way, they are called "copolarized", otherwise they are called "contrapolarized". The electrons and the protons are considered as electropolarized whirls and the positrons and the light quanta of cosmic rays are considered as magnetopolarized ones. When the distance between the centres of the two "whirls" is not too small it is found that copolarized whirls of similar structure and same size repel each other in accordance with the inverse square law. If the dimensions of one are much larger than the dimensions of the other then they attract each other according to inverse square law. The magnitude of force of attraction between polarized whirls of unequal dimension is found to depend upon the ratio of their masses. It is found that when the ratio of the masses attains a certain numerical value, the force of attraction becomes equal in magnitude to the force of repulsion between two identical whirls. It is interesting to note that this numerical value is very nearly equal to the observed mass ratio of the proton and the electron.

It is also found that if the dimensions of two "contrapolarized whirls" greatly differ they also attract each other in accordance with the inverse square law, but the magnitude of the force is much smaller than what we get in the case of "copolarized whirls" of the same relative dimensions.

Japolsky also suggests that the great velocity of cosmic ray particles may only be apparent, and that their high penetrating power may only be due to the relatively small value of the mutual forces of the contrapolarized whirls. But his suggestion about the cosmic ray particles seems to be highly speculative.

The beauty of Japolsky's theory is that all elementary particles are supposed to be nothing else but "electromagnetic whirls", or their combinations, and that in any system of "whirls" the principle of relativity, whether general or special, is a necessary consequence of their classical electrodynamical features.

The Fiftieth Birthday of Niels Bohr

(October 7, 1935)

The name of Professor Niels Bohr is too well known to every student of physical science to require any introduction. With Lord Rutherford and Einstein, he is one of the few who are real creators of modern atomic physics, and one who has placed his name in the "Hall of Immortality" for all times to come. It will interest the reader of SCIENCE AND CULTURE to know that recently (on the 7th Oct, 1935) Prof. Bohr celebrated his fiftieth birthday. On behalf of his many Indian admirers and followers, we offer our heartiest felicitations to the renowned physicist and hope that many years may still be spared to him to advance the bounds of human knowledge. Regarding his contributions to scientific knowledge, we can do no better than quote the substance of the fiftieth birthday notice published in the *Naturwissenschaften* of Oct. 4, 1935, from the pen of Professor W. Heisenberg, one of Bohr's most eminent pupils—

On the occasion of Niels Bohr's fiftieth birthday, it is permissible for one who has been lucky enough to take part in his scientific activities to take a retrospective view of the various stages of his life-work which has led in such a straightforward and successful way to the realization of its goal.

When Bohr founded the modern theory of the atom in 1913 with his paper on the hydrogen spectrum, its substance-matter was, as Bohr himself remarked, in striking contrast to the admirably worked out circle of ideas which we call classical physics. Bohr has a peculiar attitude towards the problems of reality, and this has formed the fundamental basis of all his creative work, and braced him up to break away from the fundamental lines of earlier scientific thought and to lead him to the conviction that it is only by emphasizing the contrasts of the classical theory with the new theory that we could come to new ideas.

To his students it has appeared that Bohr is more conscious than any other investigator that every attempt for understanding Nature must hover about a bottomless depth, that between the stages when we become conscious of a really objective outer world and when we have full knowledge of it, there cannot possibly be a well laid out road which will lead from sure grounds of known regions to the unknown new lands. Whoever reads Bohr's works exhaustively gets the impression that for Bohr every new problem is, in a certain measure, a new form in which the general problem of knowledge presents itself.

As a result of such an attitude towards scientific problems, Bohr was led to formulate the Correspondence Principle, in which the unbridgable differences between classical and quantum theoretical laws were used for a deeper penetration into the yet closed regions of atomic mechanics. This intuitive kind of investigation bore rich fruits in the theory of periodic systems in the year 1921, when Bohr succeeded, without possessing any knowledge of the exact forms of natural laws which control the formation of atoms, in working out a complete model of the formations of shells of the electronic envelope; even today this picture is as much correct as any model can be. In 1927, Bohr gave in his analysis of the physical fundamentals of the new quantum theory a striking demonstration of his general philosophical insight, and of the comprehensiveness of his methods of investigation. The remarkable results which force us to a revision of the ideas of the outer Objective World of Reality in the region of atoms are found very elegantly worked out in the epistemological ideas, which Bohr has taken from the very beginning as the basis of his scientific investigation. He thus succeeded in understanding and penetrating the laws of quantum mechanics, which otherwise appear so paradoxical, to their bottom. That even this part of Bohr's work and its continuation will form the fundamentals for the

further progress of atomic physics is known to all investigators who exert themselves in the advancing of this branch of knowledge.

To those scientists who have been lucky enough to be allowed to work in Bohr's Institute at Copenhagen, another side of his work is also important – the creation of a spiritual centre in which the different lines of thought in modern natural sciences unite and intermingle on the general philosophical basis of all sciences. The extraordinary influence which Bohr has exerted and still exerts on his pupils is founded on this unity of thought, in which every scientific question, as well as the life itself, is drawn towards the same unalterable centre.

On account of this personal magnetism of Bohr, the Copenhagen Institute has become the spiritual centre of modern atomic theory. Let us hope that even in future when biological and other general questions are taken up there, its position will remain reserved with time: we willingly entrust ourselves to such leadership.

RANDOM NOTES

It is claimed on behalf of a contemporary scientist that on the average, there is a paper from his laboratory every third day. The news will be very welcome to the paper merchants.

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Somebody asked Prof. Niels Bohr: There are now so many scientific journals, and so many contributors, some of them very prolific (*e.g.* writing one paper every third day, and publishing it too!). How do you manage to read so much!

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Prof. Bohr replied, "when I find that a writer is in the habit of writing only one paper per year, I read it from the beginning to the end. When he writes two papers, I read them, but not so thoroughly. When the production is three papers per year, I only read the titles and conclusions. When the productivity exceeds this limit, I do not look at the paper!"

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Somebody asked Goldsmith: How many potatoes will reach to the moon? His reply was "One, if it is long enough."

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Question: How many papers make a man famous?

Answer: One, if there is new substance in it.

G. M.

Obituary

Dr. P. Bruehl

Dr. Paul Johannes Brühl, I.S.O., D.Sc., F.C.S., F.G.S., M.I.M.E., F.A.S.B., son of Michael Brühl, was born on the 25th of February, 1855, in his native village of Weifa in Saxony (Germany). He had a brilliant career in the German schools and colleges and from a very early period evinced a great interest in the study of plants. After finishing his usual courses in the German universities, he, as was customary in those days, walked from his own country to India to increase his knowledge of the tropical floras. During

his tour he made collections in Central Europe, Asia Minor, and Armenia, and reached India in August, 1881. He secured then an appointment in the Rajshahi College, Bengal, in 1882, as a Professor of Natural Sciences. During his stay for about five years in the Rajshahi College, Dr. Brühl's reputation and popularity as a teacher and his sympathy towards the students were known far and wide. During this period, in 1883, he married Annie Betts Fox, a highly enlightened and cultured lady. Prof. Brühl's interest in the botanical studies in India and educational activities in general were gradually known to the higher authorities and reached the ears of Sir George King, the then Superintendent, Royal Botanic Garden, Calcutta. Through his influence Prof. Brühl was transferred to the Engineering College in 1887 as a teacher of Physics. During his stay in the Engineering College he availed himself of the opportunity of working in the herbarium of the Royal Botanic Garden, Calcutta, in his off times. He served the Engineering College in various capacities teaching various subjects such as Chemistry, Physics, Geology including Mineralogy, Mechanics, Heat Engines and Agriculture. His fairly sound knowledge of various scientific subjects and command over about 17 languages made him an ideal teacher who could not only enable his students to have a solid foundation in the subjects he taught, but also fostered in them a quest for higher research works. To quote late Sir Ashutosh's words "his wide and varied knowledge of many branches of science both theoretical and practical including Mathematics" stood him in good stead in imparting proper type of teachings to the students.

He officiated as the Principal of the Sibpur Engineering College towards the latter part of his service there. He had also the occasion of supervising the large electric plants of Kidderpore Docks and Belvedere. He was one of the most prominent figures in the Botanical Garden and Engineering College, and the popularity both of Dr. Brühl and Mrs. Brühl is still a house-hold word among many of his students who are at present holding high offices of Government and elsewhere. In 1912, he retired from the Government service at the Engineering College and left for Bangalore to carry on further research work in Chemical Geology at the Indian Institute of Science, Bangalore. He was at this time lecturer in Geology and Mineralogy, Presidency College, Calcutta, and officiated for some time as Patent Secretary to the Government of India. In 1913, he

was awarded the insignia of the Imperial Service Order for rendering his long and faithful service for 31 years to the Government of Bengal. After the retirement of Dr. G. Thebaut the late Sir Ashutosh Mukerjee appointed Prof. Brühl as the Registrar of the Calcutta University on the 31st March, 1913. During this time Prof. Brühl was of very great help to Sir Ashutosh in building the scientific department of the Post Graduate standard of Chemistry and Physics at 94, Upper Circular Road, Calcutta, and the *Biological Laboratory at 35, Ballygunge* Circular Road, Calcutta (late Sir T. N. Palit's residential house). His meritorious service as the Registrar at that time was highly appreciated and has recently found its expression in the following words of the Vice-Chancellor, Mr. Shyma Prosad Mukerjee, in the Senate Meeting: "Dr. Brühl was a valuable worker of the University and was responsible for the duties which are now divided between the Controller of Examinations, Secretary of the Council of Post Graduate Teaching in Arts, and the Registrar". In spite of Dr. Brühl's varied activities during his whole career he spared no pains to contribute to the advancement of botanical, chemical and physical researches, during the latter part of his life. After his 6 years' service as Registrar of the Calcutta University, Sir Ashutosh Mukeejee entrusted in him the responsible work of the University Professor of Botany. As Professor of Botany Dr. Brühl equipped the Science College at Ballygunge with the most up to date apparatus suitable for the research work of the Post Graduate students. The laboratories fitted up are in no way inferior to some of the modern laboratories in Europe and America. During this period as Professor of Botany of the University of Calcutta in charge of the Post Graduate Department of Botany Prof. Brühl was able to fulfil a long cherished hope of creating a botanical school in Calcutta for higher researches by contributing papers of very high standard in collaboration with his students—some of whom are very successful at present. The publications of his botanical investigations are too many to mention here. He was one of the pioneers of botanical researches in India by contributing monographs in collaboration with the late Sir George King in the Annals of the Royal Botanic Garden, Calcutta. Sir David Prain C. M. G., D.Sc., F. R. S., &c., formerly Director, Royal Botanic Garden, Kew, once wrote to Dr. Brühl: "What you are doing on the algae, Mysoeomycates and Mosses, if only you will publish your results, will be of much greater value to Indian Botany, and I wish you would do a local flora of these because yours would be a pattern how such a flora ought to be done. As a teacher of the Research Colleges, he created interest in many branches of Botany such as Algology, Bryology, Mycology and Ecology. His recent books entitled "A Guide of the Orchid flora of Sikkim", "A census of Indian Mosses", published immediately *before* his retirement from the post of the University Professor of Botany are now widely consulted. He was one of the founders of the Indian Botanical Society and is one of the most active members of the Council of the Asiatic Society of Bengal. He was also a member of the Syndicate and a fellow of the Calcutta University and thus offered his quota of experience and erudition to the advance of knowledge. In 1925, he was deputed by the Government of Bengal to carry on physiological investigation in Water Hyacinth and allied subjects. He published many papers on this vegetable pest which are of considerable importance in tackling the problem of the eradication of this plant. In 1926 he retired from the University.

Forty-five years of consecrated service for the development of the educational activities of this province made Dr. Brühl a genuine well-wisher of this country. Mrs. Brühl also took keen interest for the welfare of prof. Brühl's students and her capacity to speak Bengali fluently endeared her to many Bengalee families among Dr. Brühl's students. The days of Dr. and Mrs. Brühl would be remembered from generation to generation in many Bengalee homes.

We all pray for peace for the departed soul of this venerable teacher.

—K. Biswas.

P. C. Basu

Pravash Chandra Basu, M. B., M. Sc., P. R. S., a young anthropologist barely thirty one years of age, died suddenly on Friday the 6th September 1935, leaving behind a large number of friends and relatives to mourn his loss. Dr. Basu was one

of the most distinguished scholars of Bengal. He not only stood First class First in the B. Sc., and M. Sc. examinations of the University of Calcutta, but had also a brilliant career at the Medical College, Bengal, and was awarded the college scholarship. He stood first with honours in Dental Surgery. He was awarded the Post Graduate Jubilee Scholarship, the Post Graduate University Research Scholarship, the Govt. of Bengal Research Scholarship, and various Gold Medals, and prizes, *viz*. Matilal Mallick Gold Medal, University Gold Medal, University Mouat Gold Medal, Haripada Daw Gold Medal. He was the first medical graduate to obtain the

Premchand Roychand Scholarship. His research works and papers on Anthropology and Ethnology published in the Asiatic Society of Bengal, Zoological Survey of India, and Bose Research Institute, had won for him the admiration of the scientists of India and abroad. Dr. Basu was attached to the Bose Research Institute, Calcutta, in Biology Department and was the principal collaborator of Dr. B. S. Guha, Anthropologist, Zoological Survey of India, Calcutta, in writing many papers on Indian tribes. He was a public spirited young man with dynamic enthusiasm for every philanthropic work, and was connected with many clubs, schools etc. His ascetic simplicity and amiable character will ever be remembered by those who came in contact with him.

Papers by Dr. P. C. Basu

1. "Head-Dress of the Hill Tribes of Assam". Paper read before the Anthropological Section of the 15th Indian Science Congress 1928.

2. "A report of the Human Relics recovered by the Naga Hills (Burma) Expedition for the abolition of Human Sacrifice during 1926-27 by B. S. Guha and P. C. Basu. *Anthropological Bulletin*, No. [illegible] Zoological Survey of India, Calcutta, July 1931

3. "A Comparative Study of Burmese Crania" (*Transactions of the Bose Research Institute, Calcutta, 7*)

4. "The Anthropometry of the Bhuiyas of Maurbhanj" (*Journal and Proceedings, Asiatic Society of Bengal* (New Series) *15*, 1929, No. 1).

5. "The Racial Affinities of the Mundas" (*Transactions of the Bose Research Institute, Calcutta, 8*, 1932-33).

6. "The Social and Religious Ceremonies of the Chakmas" (*Journal and Proceedings, Asiatic Society of Bengal* (New Series) *27*, 1931. No. 2.

7. "Some contributions to the Racial Affinities of the So-called Pre-Dravadian Tribes of India" (P. R. S. Examination Thesis for 1930, first year term).

"Anthropological Measurements and observations of the Oraons of the Ranchi District" (P. R. S. Examination Thesis for 1933, second year term).

"Anthropological Measurements and Observations of the Oraons of the Ranchi District" (P. R. S. Examination Thesis for 1930, third year term).

8. The Racial Affinities of the Oraons" (*Transactions of the Bose Research Institute, Calcutta* (in the press) 1933-34).

9. "Report on the Human Remains Excavated at Mohenjo-Daro", by B. S. Guha and P. C. Basu (in the press).

Notes and News

Civil Aviation in India

From the report on the progress of civil aviation in India for 1934-35 it appears that there has been considerable progress in all directions. Following are the main features of development :

(1) The approval of a grant of Rs. 92,57,000 for the development of air route ground organization. (2) The Karachi Lahore contract air mail service, connecting with the Empire Service at Karachi, was inaugurated by the Indian National Airways in December. (3) The air service between London and Calcutta was duplicated in January 1935, and concurrently the feeder services, Karachi-Madras and Karachi Lahore, were also operated twice weekly. (4) The British Post Office, in December, introduced a flat rate of air mail surcharge to all places in India, thus effecting a general speeding up of the inward mails and strengthening the position of the Indian internal air services. (5) In Burma, the Irrawaddy Flotilla Company registered a new company, Irrawaddy Flotilla and Airways, Limited, and commenced the operation of internal air services in Burma with seaplanes. (6) Negotiations were commenced for the reorganization of the empire air mail and connecting services, to provide a three day service to India five times a week, and to carry all first class empire mail by air. The Indian Aircraft Act, 1934, to replace the Act of 1911, and the Indian Carriage by Air were passed by the Legislature.

The Indian Internal Services comprised the following : The Karachi-Bombay Air Mail Service, Karachi Lahore air mail service, Calcutta-Rangoon air service, Calcutta-Dacca air Service, Hardwar-Gauchar air service (run by the Himalaya Air Transport and Survey, Limited) and air services in Burma.

With regard to the empire service London-Australia, Croydon-Karachi section, only one change of importance in the operation of the service, route, or fleet took place during 1934. The service, which had been operated to a six-day schedule between London and Karachi, was speeded up to the following schedule with effect from April 15, 1934 : East bound London dep. Saturday. Karachi arr. Thursday. West bound Karachi dep. Wednesday. London arr. Monday.

Fifty two services were operated to Karachi during 1934, of which 44 arrived punctually and eight were one day late. The quantity of mails carried to and from India shows a considerable increase. The weight of airmails to India alone was 29.4 tons against 24.6 tons in 1933, and the weight of mails from India was 29.8 tons against 24.2 tons in 1933. In the inward direction, the increase is over 19 per cent., and in the outward direction, 23 per cent.

The number of casual flights to and across India and form India to foreign countries was 51, an increase of 30 over the number in 1933.

During the year 1934, 18,443 hours of flying were carried out by aircraft of Indian registration, excluding the time flown by aircraft used entirely for private purposes, compared with 15,240 hours of flying during the previous year. In 1934, 26 notifiable aircraft accidents in India were recorded, compared with 29 accidents during the previous year. A very satisfactory decrease in the number of accidents due to forced landing, is of interest.

Provision of Rs. 14,24,000 was made in the Budget for 1934-35, while Rs. 16,19,000 was the budget provision for 1935-36. The increase in the grant for 'direction' in 1935-36 is due to the provision of additional inspection and other technical staff at headquarters as well as at aerodromes.

India was represented at the 22nd session of the International Commission for Air Navigation held at Lisbon in May 1934 by Mr. J. A. Shillidy, C.S.I., I.C.S.

If the announcement made in the British House of Commons in December 1934 is to materialize—as, indeed, it is anticipated—important and extensive developments of a farreaching character in the organization of empire air services can be foreshadowed. The proposals, so far as they concern India, are briefly : (1) the frequency of the service to India will be increased to four or five times a week, of which two services will terminate at Calcutta and

three will proceed across India to Singapore or Australia. The through services will probably be seaplane services. (2) The existing schedules will be considerably speeded up, the time taken between London and Karachi being brought down to a little over two days. (3) The service will carry all first class empire mail (letters and post cards). The speeding up of the schedules will involve night flying over the whole route to India and on certain sections of the route across India. The aircraft employed will be equipped to carry passengers, as well as mails, by day and night. It is expected that the necessary arrangements will take two years to complete and it is proposed that the new scheme shall be inaugurated in 1937. So far as India is concerned, the scheme involves the organization of the internal feeder services on the standard comparable, in speed and frequency, with that of the empire services. The Government of India are actively examining the whole question and its various implications.

U. P. Foreign Technical Scholarships

It is notified that Government, in the Industries Department, have been pleased to select the following candidates for the award of foreign technical scholarships, applications for which were invited this year, subject to the condition that adequate arrangements for their training can be made. The scholars will be expected to proceed abroad during the current financial year or early next year according as the arrangements for their training are completed.

A. *Long term scholarships* of the value of £150 per annum exclusive of cost of passage, tuition or other fees and approved travelling expenses, which will be borne by Government:

(1) Sugar Engineering Mr. Abhimanyu Sanghi, at present working with the Building and Universal Finance Co., Ltd., Daryagunj, Delhi.

(2) Pharmaceutical Chemistry Mr. Chandra Prakash Agarwala, Nawabganj, Cawnpore.

B. *Short term scholarships* of the value of Rs. 2,000 tenable for six months.

(1) Manufacture of high class gold nibs and fountain pens.—Mr. R. K. Tandon, C|o. Messrs. The National Pen Factory, 32, LacTouche Road, Lucknow.

(2) Manufacture of starch.—Mr. G. J. Karandikar, C|o. Messrs. The Peari Products Co., Ltd., Cawnpore.

Artificial Rubber in Germany

Regarding Herr Hitler's announcement that Germany would soon be producing artificial rubber, the Ministry of Economics says that experiment with artificial rubber have been carried out for some months. The outcome justifies the hope of final success, but the experiments have not yet been concluded. Several laboratories are engaged in this work and various kinds of synthetic rubber have been produced. As long as a product which is not absolutely suitable for commercial purposes has not been produced mass production can not be started.

Iodine from Seaweeds

Iodine can be produced from seaweeds by converting them into ashes—technically called kelp—and distilling this kelp, after proper treatment, with suitable chemicals. The industry involves collection of weeds, very often, from sufficient depths and under hazardous conditions and cannot easily withstand the competition of the cheap iodine from Chile. In *Chemistry and Industry* for August 30, 1935, attention is directed, editorially, to the action of the Irish Free State in saving this industry from being killed by erecting a new factory for extracting ashes or kelp and introducing a new marketing scheme; thus enabling the poor people of Galway to continue to earn their livelihood through this trade.

In the light of this experience, it is pleaded that the production of iodine from seaweeds be revived on the coasts of Scotland and S. W. of England; it is hinted that the proposition should not prove impractical because, besides producing other marketable commodities, the undried seaweeds can yield an invaluable substance, algin, which is used in the textile industry as a sizing agent and waterproofing compound. It is pertinently remarked that inspite of the vast resources of Chile and its careful advertising, the kelp industry round the European coast, it is estimated, produced over 170 tons of iodine, 10,000 tons of potash salts and other products such as crude common salts. The revival, it is remarked, will afford to the poor people concerned a more satisfactory method of earning their living than the present unreliable ones of fishing and farming.

It may be added that the promotion of such industries is to be welcomed on another ground as well. It is conceivable that indigenous products are utilized better, both as food and medicine, and leave fewer aftereffects than the imported material.

Model of the Normandie for Science Museum

By courtesy of the Compagnie Generale Transatlantique the Science Museum at South Kensington has secured the loan of a fine model, over ten feet in length, of the "Normandie," the world's largest liner and present holder of the Blue Riband, of the Atlantic. The model conveys to the visitor an excellent impression of the vessel's unorthodox design, with its rounded and streamlined upper works and the complete absence from the decks of ventilators, winches, etc., which would impede the vessel's speed and limit the open deck spaces available for the passengers' enjoyment. Exhibited at the entrance to the Merchant Steamers Gallery on the Second Floor of the Museum in conjunction with the numerous models therein displayed of earlier vessels from the very first beginnings of steam to the present day, the model enables the visitor to appreciate the vast strides made in the design, size and speed of passenger vessels; whilst an adjacent series of photographs gives some idea of the luxurious internal appointments of the modern liner. It is hoped shortly to exhibit also a number of technical photographs showing the construction of the vessel.

The "Normandie" has a length of 1029 feet, beam 119 feet, tonnage 79280, and turbo-electric machinery developing 160,000 horse power. Her record-breaking run, New York to Plymouth, was accomplished in 4 days 3 hrs. 25 mins. at an average speed of 30.31 knots.

Allahabad Museum

Some very interesting additions have been made to the Provincial Museum during the year. In the archaeology section, a Farman of Shah Alam II dated 1179h and ten terracottas mostly of Maurya and Sunga periods were purchased; and a very valuable stone image of Buddha was received as a present under somewhat interesting circumstaces. This remarkable piece of sculpture was discovered nearly two decades ago, along with five others which were acquired by the museum in 1917 and which formed the subject of a special Archaeological Memoir. The image was found near the Kirat Sagar tank built by Kirttivarma, the great Chandra ruler of Mahoba, and was the only specimen of the group which did not reach the Museum because the owner was unwilling to part with it. With the exception of the upper portion of the background, which is unfortunately broken off, the image is complete. *It represents Gautama Buddha seated in* padmasana. On either side we have a Maitreya and an Avalokitesvra. On the top of the halo figures is a Kirttimukha and at the upper right corner a peculiar Gandharva with the feet of a lion and a curious tail, holding a bamboo flute and standing on a crocodile. On grounds of technique and workmanship it may easily be assigned to about 11th century like the unique inscribed image of Sinhanada Avalokitesvara of the same period and discovered along with it.

In the numismatics section 73 coins representing different types and varieties of Indo-Greek, Kushana, Gupta, Mediaeval, Mohammedan and Native State coinage were added to the coin cabinet Eleven of these are gold, 47 silver and 15 copper. Among the coins is a rare gold tiny piece of King Gangaeydeva, weighing 15 grains.

In the Natural history section a number of presents were given by Lady Hailey, wife of Sir Malcolm Hailey, a former Governor of the Province

The ethnographic court being the most attractive section of the Museum, every endeavour is made to enrich it by additions of varied interest. Among the many objects is a brass four-armed image of Lakshmi Narayana, a dancing Shiva, a Buddha seated in teaching attitude and two copper yantras engraved with auspicious designs for propitiating deities. By far the most interesting and artistic are two small copper panels which vividly depict the death scenes of Ganika and Ajamil.

Copper Age Relic in Mayurbhanj

The daily press reports the discovery of a relic in the form of a flat-shouldered copper axehead belonging, according to experts to the copper age at a site called Biratgarh of Kiching in Mayurbhanj

State. Some copper Kushan coins and "Puri Kushan" coins along with stone beads of various size and colour have also been found at Biratgarh which, once a jungle covered ruin is now being excavated. A large number of copper double axeheads were discovered in the eastern part of Mayurbhanj, but the present specimen differs in shape from these axeheads. It is said that the Oriya inscription of Gajapati King Purushottama Deva of Orissa 1492 A.D., written on a piece of axehead (referred to by Sir Edward Gait and now in the possession of the Bhuyan family of village Garpada in Balasore on the eastern border of the State) is exactly similarly in form to this piece found in western Mayurbhanj

Archaeological Finds at Ujjain

An ancient well, two shell bangles, burnt and coloured pottery were discovered at Ujjain (Gwaliar) some 30 to 40 feet below the ground level by a party of archaeologists searching for traces of ancient civilization in the Narmada Valley, the excavations having been made by the torrents of water cutting through deep *nalas* near the temple of Kalika, about 2 or 3 miles from the modern town of Ujjain.

Numerous sculptures, believed by Mr. Karandikar, the hony. Secretary of the Narmada Valley Research Board, under whose auspices the survey is being made to belong probably to the early centuries of the second millennium of the Christian era, were also discovered in Ujjain, and many of these have been collected in the temple of Mahakaleshwar by the Archaeological Department of the Gwaliar State. A seated image has been unearthed with a skullstick in its left hand. Another image, about 8 feet high, shows an intricately woven garland, falling below the knees, with three inch skulls as its prominent feature. It bears a skull-mace in its left hand. Out of the left eye of the ghastly skull creeps a cobra with its diamond head reaching to the top of the skull. These finds will no doubt interest the archaeologist and may lead to throw some light on the early history of Ujjain.

Historic Discovery at Leicester

Following the uncovering at Leicester of what were once the arches of the ancient church of St. Mary, where King Richard II was buried after his death at the battle of Bosworth Field, has been discovered a leaden coffin and skeleton which, it is thought, may prove to be that of King Richard. Henry VII, Richard's successor, had a tomb of coloured marble built, but it was defaced when the monasteries were destroyed by Henry VIII, and the site of Richard's burial place was lost.

Some historians claim that Richard's bones were dug up by a mob and scattered from a bridge in the city, where a tablet commemorates this incident.

The leaden coffin has still to be excavated but the skull from the coffin has been brought up.

"The skull has a receding forehead and projecting jaw, attributes of King Richard," said Mr. L. W. Kershaw the Principal of Leicester Technical College.

Wireless for Afghanistan

The Afghanistan Government has placed a contract with the Marconi Company for the supply and erection of five wireless stations in the most important centres in Afghanistan. The installation of an up to date wireless system of communication will be a valuable contribution to the development of Afghanistan's Commercial and social relations with other countries and an equally important factor in the country's internal communication service. The most powerful of the five new stations will be situated near Kabul and the other four at Mamana, Khanabad, Khost, and Dijazangi.

The Kabul station will communicate with the principal capitals of western Europe, with Moscow, Tokio, Sanghai, and New York by means of directional aerials, and with Rio de Janeiro, Cape Town, and Melbourne with the aid of omnidirectional aerials. This comprehensive scheme of world-wide communication can, if necessary, be enlarged still further to include other places within the scope of the directional aerials, provided the wave-length is suitable. As an example, the aerial directed from Tokio and Sanghai could include Peeking.

Automatic transmitting and high speed recording is provided for one transmitting and one receiving channel, arranged for a maximum speed of 200 words per minute. The receiving and transmitting sites will be separate and will be about ten miles from the

City of Kabul, where the control office will be situated.

—*Discovery, August,* 1935.

Aerodrome at Indore

A new aerodrome is under construction at Indore. The landing ground of the Indore aerodrome is expected to be completed by February 1936, a sum of Rs. 1,57,000 having been provided for this purpose in the Budget for 1936-1937. A sum of Rs. 60,000 was provided for the aerodrome in the last Budget. The total cost of the scheme is expected to be Rs. 22,00,000. It is learnt on reliable authority that the purchase of several aeroplanes is under consideration, for the personal use of His Highness, and may also be used by State officials in any case of emergency. Facilities will be provided for night landing at the aerodrome. The site selected is near Bijasini Hill. It was inspected and approved by Commander Watt, Chief Aerodrome Officer of Karachi, and Mr. Vincent, of Messrs. Tatas. Indore is a centrally situated town, and the aerodrome is expected to serve several cross-country air lines in the future. The Air Department of the State will be under the Finance Minister, Musahib i khas Bahadur S. V. Kanungo.

Delhi's Radio Station

From a report in the *Statesman*, it appears that the wireless station in Delhi is nearing completion. The authorities successfully carried out their first test on Monday evening when two gramophone records, including extracts from La Boheme were broadcast.

The transmitter, which has been built by the Marconi Company at Chelmsford, is of advanced modern design and is immune from wave length troubles. The power used is 20 kilowatts, which is more than any broadcasting station previously erected in India. It is estimated that the station will have a practical range for modern receivers of 240 miles in daylight and 700 miles at night. It will probably operate at first on a wave length of 340 metres.

The opening ceremony will take place about the middle of this month, although the actual work of broadcasting is not expected to be in full swing until November.

Wind Power Station in U.S.S.R.

During the last decade Soviet Russia has made an enormous progress towards the industrialization of the country. The Soviet Government have paid special attention to the development of electrical resources of the nation in accordance with Lenin's dictum that communism is socialism plus electrification. Besides the huge hydro-electric stations over the Dneiper and elsewhere, attempts are being made to generate electric power by means of wind mills. A wind driven generator of 100 k.w. was erected at Balaclava in the Crimea sometime back to test how far such generators would prove successful. It appears that the results have been found to be satisfactory, for it is announced that a 10,000 k.w. wind driven power station will shortly be erected on the peak of the Ai Petri mountains in the Crimea.

The station will consist of a reinforced concrete tower 150 metres high and 6.5 metres in diameter. Two dynamos will be installed in this tower each of 5000 k.w. This wind station will work in connection with a water power station in a valley below, which will take over its output on windless days. The station on the Ai-Petri mountains will supply data for the ultimate construction of wind stations with a total capacity of 200,000 k.w. The Crimean plateau is peculiarly suitable for wind power stations since, over the year, the average speed of the wind is 7 metres per second.

Need for Tuberculosis Clinic

"The Health Department of the various provinces in India are publishing reports indicating an increase in the incidence of tuberculosis everywhere," states the appeal by the Tuberculosis Association of Bengal for establishing a central clinic for the treatment of people suffering from this disease in the province. The existing provision for admitting patients into hospitals and sanatoria where they could be treated is very insufficient and the immediate establishment of a tuberculosis clinic is a vital need of the province. The object of the Association is to have a central clinic fully equipped with X-ray apparatus, examination room and provision for accomodating patients

for a temporary period after getting artificial pneumothorax treatment. In spite of its best efforts, the Association was unable to raise the necessary funds during 1934, and for this purpose a Finance Sub-Committee was appointed early in 1935, which has so far raised only Rs. 4,846.

"An early establishment of a Central Clinic of this character is also desirable" continues the appeal, "because it will serve as a "sorting-station" to which afflicted persons could come to obtain guidance as to the nature of treatment they should adopt in their own homes, or as to sanatoria or places they could go to for a change. It is well known that tuberculosis of different types requires different climatic environments, and expert opinion is often necessary to save individuals from undertaking the expense and trouble of going to unsuitable places."

It has been estimated that a Central Clinic of this character would cost about two lakhs of rupees. At present patients resorting to the different tuberculosis dispensaries can obtain X-ray reports and get X-ray examinations on payment of a certain fee. A large number of indigent persons are thus not able to obtain the help from an X ray examination. It is suggested that a clinic of this character would be able to provide X-ray examination free of charge.

His Excellency Sir John Anderson has shown his interest in the establishment of such a clinic by promising a personal donation and issuing a message to the people of Bengal on behalf of the Association.

Rural Development in Mysore

In his recent address to the Representative Assembly Sir Mirza Ismail, Dewan of Mysore referred at length to the problems of rural construction and economic planning.

The Dewan claimed that the different government departments and local bodies had been equally active in promoting rural development. Not only had new irrigation schemes been pushed on but a continuous policy of development and repair of tanks had been maintained. Garden cultivation had been extended by giving electrical power to pumping installations at very special rates, and there were now no fewer than 370 of these in operation. Electric lighting had been extended to 130 towns and villages and it was hoped to extend it to a much larger number now that the new line to Bhadravati was complete. Nearly 145 miles of new road had been constructed in the last ten years and 352 miles of roads had been metalled. Village schools had been improved; water supply schemes for the smaller towns and villages were being pushed on; important health activities were being undertaken and several district boards had joined hands in a scheme for increasing the number of midwives.

Reviewing industrial progress Sir Mirza said that the silk industry continued to suffer from increasing foreign competition, but still the plants were in full operation and Rs. 1,08,200 worth of silk was sold last year. The demand for the products of the State Iron Works at Bhadravati continued to be poor and certain sections of plant had therefore to be operated on a restricted scale. The sandal oil factory at Mysore and the sugar factory at Mandya show progress over last year. The soap factory continued to make very good progress, the porcelain factory has likewise prospered.

Referring to new industrial schemes, the Dewan said that the Government were interesting themselves in the manufacture, of electrical fittings and the progress made so far was extremely promising. The Electrical Department was now in a position to manufacture transformers and other appliances. The Board of Industries had under active consideration schemes for the manufacture of cement, paper, ammonium sulphate and sulphuric acid. Coffee had long had an honoured place place among Mysore industries, but although the Government have had an experimental station at Balehonnur, local curing had been comparatively small. An important curing station had now been established in Mysore City, and the Government hoped that it would serve a large area not only of Mysore but also in Coorg and the Nilgiris. A proposal for the establishment of a similar station at Chickmagalur was under consideration. The Dewan referred to the recent expert inquiry into the possibilities of growing tobacco in the State and said that the expert's report showed that both the climate and soil of Mysore were well suited for this crop and that the return was likely to be higher per acre than in the case of other commercial crops. The result of experiments at Whitefield with the curing of tobacco grown on 300 acres in the surrounding villages,

was very encouraging. The idea underlying the scheme was that the buying of the green leaf from the grower, the curing, grading and marketing of the produce should be in the hands of persons who had a stake in the business, were well acquainted with the markets, and were in a position to develop the scheme to its fullest extent.

Announcements

Dr. F. G. F. Shaw, Director of the Imperial Institute of Agricultural Research, will, it is reported, act as Agricultural Expert to the Government of India, in place of Mr. B. C. Burt, who is now officiating as vice president of the Imperial Council of Agricultural Research, *vice* Sir T. Vijayaraghavacharya retired.

Dr. B. Vishwanath, Imperial Agricultural Chemist, will act as Director of the Imperial Institute at Pusa

Mr. R. H. Ritchie, Director of Agriculture, Central Provinces, has, it is understood, been appointed Director of Agriculture, United Provinces, in succession to Mr. R. G. Allan.

Mr. J. C. McDougal will succeed Mr. Ritchie as Director of Agriculture, C. P.

Mr. P. G. Dani, former Superintendent of the fruit experiment station in the Ganeshkhind Botanical Gardens, at Kirkee, has been appointed fruit expert to the U. P. Government. Mr. Dani has spent over 18 years in the fruit industry. He will act as propaganda officer and will assist the Fruit Development Board.

Dr. H. N. Randle, Indian Educational Service (retired) has been appointed Librarian and Keeper of Oriental books and manuscripts of the India Office.

The death is reported of Mr. N. Mohun Dutt, formerly State Librarian of Baroda. The late Mr. Dutt retired from State service 18 months ago.

Proposals for building Roads

The following proposals by the Provincial Governments for constructing new roads, or improving existing roads or building bridges at a total cost of 20 lakhs of rupees were approved by the standing Committee of Roads which met at Simla on September 23 last :

It is understood that the Madras Government has proposals for the biggest road programme costing half of the above mentioned amount. Among works they propose are (1) converting the arched bridge of ten vents into a girder bridge of twenty vents on the Sardar River in Vizigapatam District, (2) diversion of the Great Northern Trunk Road *via* Vizianagram, Nellimarla and Jagannadharajupuram, (3) comprehensive improvements to the road between Mongon and Kuttilangadi, in the Malabar district.

The Bombay Government has submitted proposals for improving the Bombay-Agra road, the Karwar to the Goa frontier road, and the Bombay Poona Bangalore road, at a cost of approximately Rs. $4\frac{1}{4}$ lakhs.

The United Provinces have put forth proposals for maintaining a large number of roads at a cost of nearly Rs. $1\frac{1}{2}$ lakhs.

The Punjab Government have not put forward any new proposal while the North West Frontier Province has chalked out a programme costing nearly Rs. $1\frac{3}{4}$ lakhs.

The Delhi Administration's proposals are for asphalting or surface treatment of the present roads and to improve the road on the second Jumna bridge at a cost altogether of Rs. $1\frac{1}{4}$ lakhs. After this programme is finished, Delhi provincial roads will have been completely modernized.

The Central Provinces have proposed to purchase rollers at cost of Rs. $1\frac{1}{2}$ lakhs.

Protection of Milch Cattle

In a letter addressed to the Members of the Council of State and the Assembly, the Hon. Justice Sir M. N. Mukerjee has put in a strong plea for the protection of the milch cattle in this country. The milk problem in India has really been very acute for some time past, and we all know how inadequate her supply of pure and cheap milk is. The following excerpt from Sir M. N. Mukerjee's letter will be read with much interest :

"It is needless for me to remind you of the fact that the normal span of human life in India is the lowest on earth while the rate of infant mortality is alarmingly high, mainly due to an insufficient supply of pure, cheap and nutritious food like milk, which,

in its turn, is due to the indiscriminate slaughter of prime and milch cattle. This subject has been engaging the attention of the public for a fairly long time, and any measure for increasing the supply of pure milk for the daily consumption of the people is always welcome. The Bill to protect milch cattle, introduced by Hon. Raja Raghunandan Prasad Singh of Monghyr in the Council of State, is a timely measure of this kind.

" I may add that the Bill was carefully considered and approved at a meeting of the All India Cow Conference Association. The provisions of the Bill will, no doubt, appeal to you. They aim at the protection of milch cattle and an improvement in the supply of cheap pure milk to the people.

" I would request you to give your hearty support to the Bill. You will earn thereby not only the gratitude of the Association but also that of the people of India, who are fast deteriorating, due to malnutrition and the want of a sufficient supply of pure and cheap milk."

World Economic Survey for 1934-35

The League of Nations has issued the *World Economic Survey for 1934-35* which, as usual, contains an enormous amount of information of economic and financial interest. The first chapter outlines the main features of national and international economic activity from the beginning of July 1934 to the end of May 1935. Regarding the agricultural production of the world, the Survey says that it fell in 1934 by 6 , mainly as a result of the drought in the United States. The harvests were generally worse in that year, but production was better maintained in the industrial countries where agriculture was a sheltered industry than in the agricultural-exporting countries. We are further informed that in thirteen countries—the U.S.S.R., Japan, Chile, the United Kingdom, Sweden, Denmark, Norway, Finland, Greece, Roumania, Hungary, South Africa, and New Zealand—the index of industrial production at the end of 1934 was above the 1929 average. In the principal gold standard countries, with the exception of Belgium, the indices were about 30% below 1929, and still falling.

The number of industrial workers employed in 1934 was about one-sixth less than in 1929, and in the meantime five years' new labour supply had entered the market. Unemployment therefore was still more than double what it had been in 1929. The gold value of international trade in May 1935 was slightly above its level of a year earlier for the first time in nearly six years but the increase was very slight.

The closing chapters of the Survey deal with the problems of international equilibrium, international debts, the approach to stablization, and give finally an estimate of the world economic situation at the end of July 1935.

Broadcasting Developments in India

The broadcasting system in this country is being reorganized on a comprehensive basis by the Government of India whose intention it is "to establish services in the vernacular for all India, allowing for the cultural and linguistic claims of each area; to make the short wave services of Great Britain and Europe available by relaying them to Indian listeners as alternative programmes; and to interpret India to the world through the facilities which the short wave system will offer to listeners in other countries." A recent report in the *The Statesman* says that there will be four main stations at Delhi, Madras, Calcutta, and Bombay. Two new stations are being built in Delhi and Madras and the existing ones at Calcutta and Bombay are being considerably improved. The Report informs us that the new Delhi station will employ the Urdu tongue of the North, Bengali will be used for Calcutta, Marathi and Gujarati for Bombay, and Tamil and Telegu for Madras, so that the populace may benefit largely by listening to the cultural and educational talks over the wireless. The large stations, using the main languages, will come under the direction of the Central Government, while the smaller ones which will deal with the intimate side of village life, under the Provincial Governments. Music will no doubt form an important part of the programme, and in the main stations there is likely to be a synthesis of European and Indian entertainment art to meet the changed conditions of the country. In addition, the Government desire to make the radio a new influence in the civilization and reconstruction of the village life of the country.

It is expected that the two new stations at Delhi

and Madras, and the improvements for Calcutta and Bombay will be completed by 1937. The Delhi Station is being constructed, and will embody the latest improvements in broadcasting equipment. The main wavelength chosen for initial working will be 340 metres, the precise frequency being 882 kilo cycles a second. Practically the whole of Northern India will be able to benefit by it, provided the field strength at night be on an average about one third millivolt a metre, as is anticipated.

Hydro-electric Power Resources of India

Sir M. Vishweshwarayya, the ex-Dewan of Mysore in his recent book *Planned Economy for India* discusses the problem of industrialization and the development of power resources of the nation. According to him the potential electric power resources of India is near about 27,000,000 H.P., while the power actually developed is only 800,000 H.P. or 3 per cent. When all the schemes now under construction are in full operation, this latter figure may increase to 1,750,000 H.P. Sir Vishweshwarayya proposes that a comprehensive scheme of development should be launched immediately and that no effort should be spared until at least 50 per cent of the potential power has been developed. We entirely agree with the views of Sir M. Vishweshwarayya. In a subsequent issue we hope to show how backward is India's position among the civilized nations of the world as far as available electric power per head of the population is concerned. Even such a backward European country as Bulgaria is far better off in this respect. While in countries like Norway and Canada which have fully developed their electric power resources, the power available per head is about 300 times to that in India.

Natural Gas near Ahmedabad

A recent Associated Press message from Bombay says :

It is understood that Dr. P. K. Ghosh of the Geological Survey of India, who was deputed by the Government of India to investigate and report on the natural gas fields located at Gogha, near Ahmedabad, has now concluded his detailed survey and has submitted his report.

Dr. Ghosh is of opinion that there are immense commercial possibilities if these potential gas fields at Gogha are developed along scientific lines and it is understood that Mr. Bradshaw, another officer of the Geological Survey of India who has had considerable experience in the oil gas fields of Burma, will on his return from leave in November be made available by the Government to assist in this venture.

Meanwhile, a company is being formed in Bombay with the object of exploiting these natural resources. The promoters of the company intend to generate electricity, using natural gas as the power-units, to supply Ahmedabad and other towns in the neighbourhood.

The importance of cheap power for industrial and domestic purposes cannot be stressed too strongly and it is to be hoped that the formation and successful working of this new enterprise will contribute materially towards the industrial development of Gujrat.

Dr. A. M. Heron, Officiating Director, Geological Survey of India, in a letter to the *Statesman* points out that Dr. Ghosh has made no statement about immense commercial possibilities. The investigations carried out so far are too incomplete to allow such predictions being made.

Excavations at Tell el-Amarna, 1934-35

The expedition of the Egypt Exploration Society is engaged in excavating the Royal palace of Akhenaten (*Discovery*, November, 1934), the religious reformer who built the city of Tell el Amarna as the centre of his new religion and refuge from the influence of the priests of the traditional beliefs of Egypt. "The work of the expedition during the past season was concentrated on the great hall, the harem quarter, and the approach way to the "Broad Hall," west of the harem," (*Discovery*, October, 1935). The roof of the great hall was supported by a large number of brick pillars, and the hall itself was decorated with faience tiles and naturalistic representations of flowers, and with daisies of faience inlaid. The harem quarter which must have been of singularly attractive beauty has "a garden laid out with flower-beds and possessing an irrigation system" and "surrounded by a colonnade on which were carved figures of birds suspended, head downwards, and representations of the king and queen and their daughters." The only object of gold found this

season was the model of a fish used perhaps as "part of the "ornamentation of a formal pond at the end of the garden or possibly a royal toy." Lastly, the expedition found that the carving of the sculptures which had adorned a building, known as the Shining of the Aten, enclosed within the two arms of the approach way to the "Broad Hall," and demolished early in the reign of Akhenaten, is remarkably fresh, as they had been broken up as useless and carved with sand. These things together with others including "some spirited horses, a royal head, and two heads here labelled "priests" of which the cynical arrogance could hardly be more faithfully expressed" were recently exhibited in the rooms of the Palestine Exploration Fund, London.

Palivasal Hydro-electric Scheme

Progress in the construction of the Palivasal hydro-electric scheme in Travancore State has been very rapid, 9000 ft. of the tunnel having been driven; 5000 ft. of each of the penstrock lines have also been laid. The remaining portion of 2400 ft. will be completed before November. It is expected that the structural work on the power house will be completed before the end of September. The generating plant is undergoing tests and is expected to arrive in India in the latter part of October and its erection will be completed by July 1936. With regard to transmission lines, out of 95 miles of 66 k.v. line, 40 miles of towers have been erected from Pallam to Kothamangalam, while the rest of the erection will be completed before March next. Construction of the 11 k.v. transmission line will be begun in October; its total length will be about 60 miles. It may be recalled that the project is designed to produce 9000 k.w. The total estimated cost is Rs. 70 lakhs.

-The Electrician.

Agriculture in C. P.

The report of the Central Provinces Department of Agriculture, 1934-35, published recently, makes on the whole a refreshing reading. During the year there has been a steady progress in all its main activities. An expansion is reported in the opening of seed farms, sale of improved implements and the practical demonstrations, carried out by the staff of the Department. Increased outturn resulting from the use of improved seeds is estimated at Rs. 55.70 lakhs. The year recorded further advance in the various branches of research and the rice research work made very satisfactory progress, while the results from cotton research are most encouraging. The Department has now strains of cotton suitable for all conditions of soil and climate to be found in the cotton growing districts of the province. The outstanding event of the year was the re establishment of the marketing section on a larger scale. It has been long felt that the conditions in which agricultural products are marketed in the province are not ideal, and an improvement is necessary in order to secure for the grower his due share of the final price of his produce.

A Deputy Director of Marketing and three Assistant Marketing Officers were, therefore, appointed, whose first work it will be to make an intensive survey of the existing marketing conditions for the principal crops. Efforts were made by the Department to explore a wider market for Nagpur oranges, which were also introduced into France during the year. The new schemes to be undertaken, which have only been possible by an allotment of Rs. 1.25 lakhs received by the Government of India's grant, include the opening of a farm for the Mandla district, the purchase of two tractors for the eradication of *kans* grass in the Saugor district, the provision of storage accommodation in markets for the cultivators' produce, the supply of improved bulls to district councils for cattle breeding, experiments in poultry-farming as a subsidiary industry for agriculturists, and the provision of two more cinema outfits for demonstration work.

Grant for Agricultural Research

In addition to the grants for research work at various centres in India, sanctioned by the Imperial Council of Agricultural Research, published in the last issue of SCIENCE & CULTURE p. 270, Dr. B. N. Singh, Kapurthala Professor of Plant Physiology and Agricultural Botany, Benares Hindu University, has been granted a sum of Rs. 65,250 spread over five years for research on the physiology of cane and wheat. We regret the omission in the last issue.

Surplus Lands in the Malay States

The Federated Malay States, with only 16 per cent of the total area utilized and the remainder

unoccupied and under forest, mostly primeval and uninhabited save for a very sparse population of aboriginals, calls for a consideration of the uses to which the surplus land can be put, and the abuses from which it should be safeguarded. The Chief Secretary of the States Government discusses in his report for 1934, the problems of conserving the forests and utilizing the lands now lying waste. According to him, timber both for domestic consumption and for export has in past years been derived largely from the exploitation of forest on State lands, but this source of supply is steadily contracting with the exhaustion, in the Western States, of the timber on such lands; and a problem of increasing urgency is the organization of the reserved forests to yield a continuous supply of timber. Conversion of primeval forest into regularly managed crops of young timber could formerly be effected over relatively large areas with a minimum expenditure and the trees of unwanted species could be sold for conversion into firewood but the competition of hydro-electric power and imported fuels has seriously affected the firewood trade.

The Indian Institute of Science, Bangalore

Appointment of a Quinquennial Reviewing Committee

We understand that the Government of India has decided to appoint a Quinquennial Reviewing Committee to review the work done at the Indian Institute of Science, Bangalore. The personnel of the committee has not yet been announced, but we hope that it will be such as to inspire confidence.

Meanwhile, while the matter is *subjudice* a very vigorous and inspired press propaganda has been started apparently in the name of the Institute. We have read one editorial in the *Current Science,* (Sept., 1935) another in the *Leader* of Allahabad, and probably others have appeared in south and west Indian papers. The language and tone of the editorials in *Current Science* and *Leader* are strikingly similar so that there is a suspicion that they are both inspired, and it is not difficult to guess where the inspiration comes from.

The editorial in the *Current Science* gives, with many omissions and suppressions, the history of the Institute, its present status and the status that is to be. It ends with an appeal to the patriotism of India, of the provinces, and the states, to come to the financial aid of the Institute. It quotes the opinion of the Sewell Committee :

"That the Institute ought always to be in a position to provide such opportunities as cannot be obtained anywhere else in India; that it should do what no other institution can do; that it should maintain a position of pre-eminence, that it should acquire even a world reputation and that it should become a place of reference."

We would have refrained from making any comments on the Institute, as the matter is *subjudice,* but as a propaganda has already been started we wish

to issue a note of warning to the public. There is no doubt that the main founders of the Institute *viz.* the Tata family, the Government of India, wanted the Institute to be an All-India body. But 'All-India' is a vague term, and every 'All-India' body must have a local habitation in some province or state. The 'host' in this case was the Government of Mysore which, under the influence of the Great Dewan 'the late Sir Sheshadri Iyer, offered a large plot of land to the organizers, and assurance of an annual subsidy of Rs 50,000. This is how the Institute came to be located at Bangalore.

Before the designation 'All-India' can be justified three conditions are necessary (1) that students from all parts of India should be welcome, and should be admitted to the facilities of the Institute (2) that when a post in the Institute falls vacant, opportunity should be given to candidates from all parts of India to compete for it, and the selection should be impartial (3) the workers from all parts of India should be given facilities to carry on their work in the Institute.

Unless these conditions are fulfilled, we think that the Institute has no claim on the states and provinces, not even on the Imperial Government.

The present director Sir C. V. Raman took charge on April 1, 1933. He was a research professor at Calcutta unburdened with any administrative duty. Within the short course of time he has been in charge, revolutionary changes have been introduced. Most of the old staff is gone, a new department has been created, old departments have been reshuffled, and many new appointments have been made. Facts go to prove that in almost all the new appointments made so far people from South India, and belonging to a particular community have got undue preference. In a particular department, almost all the students and workers have been South Indians of a particular community. Old hands, who have served the Institute for years faithfully, have been displaced or attempted to be displaced, in the name of retrenchment while new Messiahs have been brought from Europe to give inspiration to the Director's pupils. We have no objection against such procedure, provided the Director finds out new sources of revenue for inviting foreign guests.

G. M.

Research Notes

An Inscription in the Bhaikshuki Script

In 1888 Bendall announced the discovery of some manuscripts in Nepal written in a script of the 'arrow-headed' variety (*Verhandlungen des VII. Internationalen Orientalisten-Congresses*, Arische Section, pp. 111 f.). This was followed in 1890 by his publication in *Indian Antiquary*, Vol. XIX, pp. 77 f. of a Buddhist plate from Gaya written in the same script. With some hesitation he identified this strange script with the *Bhaikshuki Lipi* mentioned by Al-Beruni as current among the Buddhist monks of Udunpur, evidently Uddandapura near Nalanda. The script is an independent development from the ancient Brahmi, and, according to Buehler, shows affinity with the southern scripts (*Indian Antiquary*, Vol. XXXIII, 1904, Appendix, p. 60). Altogether only five or six epigraphs in this script are known to exist, but of these only the Gaya plate was so far available to us. Its photograph has been recently republished in R. D. Banerji's *Eastern Indian School of Medieval Sculpture*, pl. lxvi (*c*).

One more record in this script has now been added to the list. It comes from Kara (Allahabad district), though the original provenance is unknown, and is now deposited in the Allahabad Municipal Museum. Like the Gaya plate, the plate bearing this inscription also was shaped for the purpose of being fixed to the bottom of some metal image. The inscription records the gift of the image by Queen Candalladevi, a female lay worshipper and the wife of the Ranaka Mahipala. It has been published by Dr. N. P. Chakravarti in *Epigraphia Indica*, Vol. XXII, pp. 37 f.

A. Ghosh

New Velocities of Extragallactic Nebulae

Our readers are probably aware of the Theory of Expanding Universe according to which the Universe is expanding and at a rate which is proportional to the distance of the object from the observer. A good way of grasping the concept is to imagine that the world is like the surface of a foot-ball or rather the skin of a four-dimensional sphere which is expanding uniformly. An observer on the skin of the foot ball will find that every point on its surface is receding from him, and with a velocity which is proportional to the distance of the point from him, provided the distance is measured on the surface along the great arc joining the observer to the point.

The theoretical basis for this law was supplied by Einstein's Theory of Generalised Relativity and the law itself was deduced by Friedland and Le Maitre. The experimental confirmation was furnished by Drs. Hubble and Humason of the Mount Wilson Solar Observatory, Pasadena, California. They chose for observation, nebulae lying outside the Milky Way.

These nebulae consist of enormous clusters of stars lying millions of light years away, and may in reality constitute other Milky Ways. Hubble and Humason found that the velocity of recession was about 562 Kms. for a distance of one mega per sec., (a little over three million light years) and they verifed the law for a large number of nebulae. Recently they report having measured velocities of recession amounting to 40,000 Km / sec. in Boetis cluster and in Ursa Major II cluster. This is about 1/7 the velocity of light, and even for such objects, the distance-velocity law is found to hold good.

The velocities are of course deduced from the shift of spectral lines to the red, but there is a difficulty in interpreting these shifts as indicating a recession of the object observed, for if the world be really expanding at this tremendous rate, it can be shown that about a thousand million years ago, its size was only a moiety of what it is now, and all the matter which is now contained in the universe was packed in much less space. But it is inconceivable that the world was very different from what it is now a thousand million years ago, for Geology says that even the Earth, which is a tiny spark cast off by Sun, was not much different in its physical condition a thousand million years ago. The time-scale of evolution of the Universe is immeasurably larger than

thousand million years. The velocity of recession of extragallactic nebulae continues therefore to provide the scientific brains an exciting puzzle for many years to come!

Sir A. S. Eddington on the Speed of Recession of the Galaxies

In the Monthly Notices of the Royal Astronomical Society, June, 1935, Sir A. S. Eddington revises his calculation of the velocity of recession of extragallactic nebulae per million light-years. His new figure is 865 Km. per sec. for a distance of one mega per sec., instead of 528 Km. given previously. Sir A. S. Eddington is so sure of his calculation that he thinks that the distances of nebulae which are calculated from the periods of Cepheid Variables should be reduced by 20-30 per cent.

Eddington's calculations are based on a highly speculative cosmological theory in which attempt is made to blend the generalised theory of relativity, wave mechanics, and the origin of fundamental particles into one complete whole. Some of the results are extremely startling, for example, when he asserts that the classical radius of the electron (1.3×10^{-13} cm.) is equal to the radius of the Einstein Universe divided by the square root of the number of particles in the Universe. Thus according to Eddington the total number of particles in the Universe control the size of every individual electron. To many thinkers, this will read like a new Astrology but Eddington backs his deductions with an impressive array of mathematical formulae and figures.

Eddington is now inclined to think that the number of particles in the Universe is $2^{256} \times a$, where $1/a$ is Sommerfield's constant which ought to be 137 according to Eddington's speculation, but the constant obstinately refuses to be a whole number and the most recent experiments show that it is about 135.82. So Nature does not always insist on an integral number. The mathematician's weakness for whole numbers appears to be as old as creation. Phythagorean mystics held that "integral numbers rule the Universe." But the beautiful hypothesis was spoiled by sceptics who proved that the ratio of the diagonal of a square to its side ($\sqrt{2}$) cannot be expressed in integral numbers (incommensurable). But, undaunted by this failure, Kronecker could say, " God created the integers, the rest is the work of men," for he proved that $\sqrt{2}$ can be represented by a continued fraction. Even now, the quantum physicists refuse to look at anything except at integral numbers. We are perhaps reverting to the mysticism of the pythagoreans. There are certain points in Eddington's Theory to which legitimate objection can be taken. In Eddington's picture, the fundamental particles are electrons and protons. But after 1931, when his first speculation appeared, new fundamental particles, the positron and the neutrons have definitely made their appearance. The " neutrino " is in the air, and the " free magnetic pole " may any day make its appearance. The cosmic rays have also been shown to consist of some kind of charged particles. All these give a certain amount of unreality to Eddington's census of total number of particles in the Universe and the magic formula by which it is represented.

The Racial Question Theory and Fact in the Antiquity, Sept. 1935

Profs. Julian Huxley and A. C. Haddon contribute a thoughtful article under the above heading in which the racial problems of the twentieth century politics are critically examined. The importance of such a study will be apparent to the thoughtful reader who has studied the course of history in the current years, for inspite of the so-called liberalism of the present century Nazi Germany is subjecting the Jewish community to extremely harsh treatment and the United States of America passed some years ago some very harsh measures prohibiting the immigration of the Japanese and other Asiatics and the Southern Europeans. Both these countries take shelter behind science for the justification of these measures. According to Nazis their country is full of full-blooded Aryans and the purity of the stock is in danger of being contaminated by admixture with inferior Jewish blood. The American professors who are behind their hard immigration laws were actuated by a similar belief in the superiority of Nordic blood.

The aforesaid writers find an analysis that the word, race, is used in a number of different senses. First, race as an anthropological term to denote divi

sions of mankind who are divided from each other by different, physical and probably also, mental characteristics. Secondly, the word, race, is used to denote persons speaking the same or related types of languages, as for example, the Aryan race or the Latin race. Thirdly, "race" is used to denote communities which are bound by common religions and social tradition, as for exa.nple, the word Jewish race, in Europe or Islamic race in India. Fourthly, the word, race is also used to denote national groumps, as for example, the term German race or the Italian race. According to the authors, the second, the third and the fourth connotations of the word 'race' are absolutely meaningless and they propose that even as regards the first, the word 'race' should be replaced by such harmless terms as ethnic group. They opine that probably originally there might have been ethnic stocks differing completely in physical features and may be in mental vigour as well, for example the tall and blonde Nordics, the mediumstatured round-headed Alpines, the short dark haired Mediterraneans, the typical Negroes, the Chinese or the Bush man or Negritoes. But in course of time all these original races have been so far intermixed that no country, Germany and America least of all, can boast of possessing pure ethnical stocks. Moreover, the original characteristics of these hypothetical pure stocks can only be recovered by an intense study of the existing groups of men with the aid of Mendel's law of heredity. But at the present time it is very difficult to say as to which stock has the ideal qualities and which the less desirable ones. The sense of race superiority is largely the result of the temporary excellence possessed by one group of men over others, but such superiority may be ephemeral. Thus, even such an acute brain as Aristotle's held the opinion that the Greeks are by nature destined to be the greatest race in the world, as Nature had favoured them with the best climate and the best physical and mental equipment. He held that the Southern races had, on account of great heat, been incapacitated from rising to higher levels, while the Northern barbarians were, on account of the severity of the climate and innate mental and physical deficiency, incapable of rising to the level of the Greeks. He would have been surprised to see one of these southern races living in hot Arabia rising to as great, intellectual and moral level as the Greeks, and after them the descendants of the Northern barbarians rising to higher levels in culture and civilization—than even the Greeks. The authors opine that twenty or thirty generations hence who knows the negroes of Africa may not excel the present day Europeans in culture and civilization. The authors plead for a dispassionate study of the biological problem of the improvement of the human race which alone is capable of evolving a better race than the present *homo sapiens.* The authors show that there has never been an Aryan race, or a Latin race; the so-called Jewish race has no ethnic meaning. There have been Mongolian Jews, Tamil Jews, Negro Jews. Even in Palestine at the time of their appearance in history, the Jews were a mixed race. In every country they have intermixed with the popution. Similarly to speak of a nation, which denotes Communities bound up by common political interests as a race is a great blunder and a deliberate misuse of the term.

Hair Examination

Madeline Kueberg in *Am. Jour. Physical Anthropology 20,* 51-61, 1935, gives a detailed description of improved technique for microscopic examination of human head hair. Wooly haired Negroes were so long differentiated as having hair with narrow-oval cross section and straight haired Mongol hair possessed round cross section and Caucasic wavy hair was intermediate. For exactitude, the ratio of the shortest to the longest diameter of the cross section was used as hair index which gives a satisfactory numerical value to a particular shape, when circles, ovals and ellipses are considered. It has now been clearly demonstrated that hair form and the shape of the cross section of the hair shaft are not interdependent and the form cannot be predicted from the shape of the cross section and that hair index is not reliable as a racial criterion and may lead to fallacious generalizations.

P. Mitra.

The Nasion in the Living

This is one of the most important anthropometric landmarks, and has given rise to much difference of opinion. By examination of 140 freshly deceased human bodies and X-ray studies in the living male

Mr. M. F. Ashley Montagu sets the question at rest by showing that the situation of the nasion in the living is to be looked for at the point at which a horizontal tangent to the highest points on the superior palpebral sulci intersects the dimsagittal plane (*Amer. Journ. Phys. Anthrop.* June 1935, p. 81—93).

P. Mitra.

Development of Trunk Width

Davenport has a valuable ontogenetic and phylogenetic study of the biacromial trunk width in relations to the maximum horizontal distance between the lateral margines of the pelvis the bi-acromial width of boys exceed that of girls except during girls' juvenility when conditions are reversed. Racially the Negroes have broader shoulders than the European stocks. In all races, the relative bi-acromial width decreases to the adolescent period, and then rises slightly. The trunk broadens at shoulder faster than it grows in length from seventh to the twelfth or thirteenth year after which the length grows faster for two or three years after which the breadth at shoulder tends to increase slightly. The ratio of bi-acromial width to sitting suprasternal height between 7 and 19 years is about 66 p.c. It tends to increase slightly during childhood, decrease during maturity, and increase again. The trunk breadth index of the three-month foetus is like that of certain lower mammals like the cat. The five-month embryo has a ratio like that of the lemur, the ratio found at birth resembles that of a chimpanzee. Thus the human foetus passes in its development through a series of stages paralleling the conditions of lower mammals. The change in the angle of the shoulder blade with the frontal plane bringing about the widening of shoulders tends to decrease from 60° to 30° changing from the ungulate to the human type Thus from the fourth month onwards the changes in the trunk breadth proportions are carried on in the lines of upbuilding in Primates and other mammals till differential human development sets in. (*Human Biology*, May, 1935).

P. Mitra.

University and Academy News

Academy of Sciences, U.P.

A Special Meeting

There had been a large number of eminent scientists of India on the rolls of the Academy of Sciences, U. P. as ordinary members who could not be elected Fellows of this Academy, as the maximum number of Fellows was only thirty. To provide an opportunity for these scientists to become Fellows of the Academy and to make it conform formally to its real position, the Academy of Sciences, U.P., in a special meeting held on 18th September, 1935 at 4 P.M. in the Physics Lecture Theatre, Muir College Buildings, Allahabad, unanimously resolved to change its constitution. The important changes are that the Academy will in future be styled as "The National Academy of Sciences, India" and that the number of Fellows be increased from thirty to hundred.

The modified Rules and Regulations will be confirmed by the Academy of Sciences, U. P. in a special meeting after a month.

Ordinary Monthly Meeting

The Ordinary Monthly meeting of the Academy of Sciences, U. P. was held on September 18, 1935 in the Physics Lecture Theatre, Muir College Buildings, Allahabad at 4-30 P.M. Prof. N. R. Dhar, President of the Academy, was in the Chair.

The following papers were read and discussed :

1. Radha Raman Agarwal & Shikhibhusan Dutt : The Chemical Examination of Punarnava or Boerhaavia diffusa Linn. PART II.—The isolation of an alkaloid Punarnavine.
2. B. P. Pande : On amphistomes with central pouch from India.
3. Harishikesha Trivedi : The absorption spectrum of hydrogenchloride molecule and its upper unstable state.
4. Har Dayal Srivastava : New Hemiurids (Trematoda) from Indian Marine Fishes. PART I.—New Parasites of the subfamily Prosorchinae Yamaguti, 1934.
5. Har Dayal Srivastava : New Allocreadids (Trematoda) from Indian Marine Fishes. PART I.—New Parasites of the Genus Halicometrina Linton, 1910.
6. Har Dayal Srivastava : New Allocreadids (Trematoda) from Indian Marine Fishes, PART II.—New Parasites of the Genus Decemtestis Yamaguti, 1934.

The paper of Mr. Trivedi evoked lively interest. Mr. Trivedi showed that by the help of a theory developed by him previously he has been able to calculate the form of the potential energy of the unstable state of hydrogenchloride from the measurements of its absorption co-efficient. The form has been konwn only qualitatively up till now.

The Agra University authorities have, it is understood, decided to make a contribution of Rs. 250 to the United Provinces Academy of Sciences.

It is reported that Nagpur University authorities have made a contribution of Rs. 100 from this year's savings to the United Provinces Academy of Sciences, Allahabad, in response to the latter's request for a grant from the University.

Calcutta Geographical Society

Second Annual Meeting

Dr. A. M. Heron, Director of the Geological Survey of India, presided at the 2nd annual general meeting of the Calcutta Geographical Society, many distinguished visitors being present.

The Secretary's report revealed an increased membership and increasing public interest in the activities of the Society. He stated that the Vice-

Chancellor of Calcutta University has consented to become a patron of the Society.

After the election of Office-bearers, the President delivered a most illuminating and interesting address on "Earthquakes," illustrating his talk with lantern slides.

The following Office-bearers for the year 1935-36 were elected :-

PRESIDENT : Dr. A. M. Heron.

VICE-PRESIDENT : Messrs. W. D. West, W.D. Wadia and A. F. M. Abdul Ali.

JOINT SECRETARIES : Dr. M. Chatterjee and Mr. D. P. Ghosh.

TREASURER : Mr. B. N. Maitra.

MEMBERS OF THE COUNCIL : Messrs. B. M. Mazumdar, K. C. Roy Choudhuri, N. C. Bhattacharya, Dr. H. C. Roy, Messrs. S. C. Sarkar, N. N. Chatterjee, U. P. Mukherjee, Miss Rani Ghosh, Messrs. J. K. Das, B. Nag and P. K. Samaddar.

Agra University

The faculty of Arts, Agra University, have introduced separate Boards of studies for Hindi and Urdu from 1934-35 and Gujarati and Bengali have been added to the list of vernaculars.

The question of instituting a course in pharmaceutical chemistry is being considered by the Faculty of Science.

The annual report of the University states that the year 1934-35 opened with a balance of Rs. 11,274. The income and expenditure amounted to Rs. 1,63,924 and Rs. 1,66,634 respectively, and the closing balance was Rs. 8,564. The Government made grants of Rs. 41,855 for general purposes and Rs. 8,600 for scholarships.

The income from examination fees decreased from Rs. 96,786 in the previous year to Rs. 91,708 in the year under report. This was mainly due to a revision of the old scale of fees.

Letters to the Editor

(The Editor does not hold himself responsible for the opinions expressed in the letters).

Bengal Rivers and Their Training

In your issue of June, 1935, there is an article on "Bengal Rivers and Their Training" by Dr. N. K. Bose. I am in entire agreement with him as to the value of models ***for confirming*** how to deal with river problems but there are many statements in his article with which I cannot agree.

The maximum flood of the River Ganges near the Hardinge Bridge is not 20 million cusecs but 2 million cusecs.* Professor Gibson has been experimenting with a model of the Severn, in connection with the proposed Severn Barrage, and not with the River Mersey. The Mersey River experiments were carried out by Osborne Reynolds in 1885.

A point to which I take objection is the statement—"for the last few years in the Punjab, Bombay and Sind, where researches on models are being carried on ***more or less systematically***. The Punjab leads the way in this...."

To talk of hydrodynamic research work being carried out at Lahore "more or less systematically" is not, I am sure, a fair statement ; and it is certainly not a fair statement as regards the Bombay Presidency. Actually, experiments have been carried out in connection with the Indus River and the Nara River, which have been at least as valuable as anything produced in America or on the Continent ; and at the present time experiments are in progress at the Khadakvasla Hydrodynamic Research Station near Poona on 2 models of the River Ganges -one to a scale of 1/500 longitudinal and 1/72 vertical for a length of the River Ganges from 18 miles upstream of the Hardinge Bridge to 6 miles downstream ; and a small scale model, 1/2000 longitudinal, which covers the whole length of the Ganges from the Baral River near Sardah- 36 miles above the Hardinge Bridge down to the Gorai River, 12 miles below the Hardinge Bridge. Simultaneously, experiments connected with river training works are being carried out in two channels of 15 ft., one of 12 ft. and one of 4 ft. ; and valuable results have been obtained. There are also several other models of great interest and value, including a full scale siphon spillway which discharges 520 cusecs of water and a glass-sided model, to 1/8th scale, to show its action.

The impression given by Dr. Bose's paper that in order to learn about hydrodynamics and river training you have to go to the Continent or America is definitely incorrect. In several particulars, Indian engineers and research workers lead the world.

*The error was due to a printing mistake which we regret.

—*Editor*, Sc. & Cul.

Finally, Dr. Bose's paper may give the impression that we, in India, can do what has been done on the Mississipi River in America. We certainly could, if we had the funds. Unfortunately, this is not the case.

5.9.35. "CAVE".

The Draft Rule called the Indian Electricity Rules

It appears from a recent notification issued on the 16th March by the Department of Industries and Labour, that the Government of India propose to standardize 230 volts A. C. as the pressure for the distribution of electrical energy for industrial and domestic purposes. This voltage, as is well known to the public, is fatal to human life, since the maximum value of the voltage is $230 \times \sqrt{2} = 325$ volts. This maximum occurs one hundred times a second in a fifty cycle supply.

Death due to electrocution is mostly due to paralysis of the heart, which stops functioning when a current of a few thousandth of an ampere passes through it. All animate and inanimate objects offer a sort of resistance to the passage of electricity, and hence the more the electric pressure in the supply mains, the more is the current passing through the body of a man coming in contact with the wires, and naturally greater are the chances of his death.

In addition to the chances of greater current passing through a man due to high voltage in alternating current supply, there is another serious disadvantage. No sooner a man touches a direct current supply wire than is he immediately repulsed, but in the alternate current supply it becomes difficult to release oneself from the live wire, and hence the current passes through the body for a longer period.

In order to reduce the chances of fatal accidents, the scientists have devised the method of earthing the various domestic things, such as fans, heaters, etc. But earthing has more often than not been found to be faulty. The idea behind earthing is that a low resistance alternative path may be provided for the electric current. But unless the earthing provides a really low resistance path there is always a possibility of development of high electric pressure at the fan or other things which have been earthed and life is not safe.

Even after taking full precautions in domestic house wiring by competent licensed contractors, a correspondent

in North England wrote to the *Electrical Times* (5th April, 1934) "that he has had occasion during the past few months to inspect and report on work carried out by registered electrical contractors in his district and that 99% of the installations reported were found to be in deplorable condition and totally unsafe". Naturally if such is the case in England where 220 volts alternating current has been adopted—how much worse it might be in India!

"In the course of the last 35 years during which the Calcutta public have been using the D. C. current, there has occurred scarcely any death due to 220 volts D. C. whereas the number of fatalities due to A. C. current has been as high as 26, and that, too, only in the course of the last three years (*Commercial Gazette*, 1934). In the Benares Hindu University there has been not a single fatal accident using D. C. 220 volts during the last 15 years, whereas in the Benares city using 230 volts A. C. there have been more than two dozen cases of electrocution.

Even in England where greater efficiency is expected, Scott Ram reported 6 deaths for the period 1911 to 1921, from contact with 250 volts D. C. or less (1 from shock and 6 from burns), whereas during the same period he reported 150 deaths from contact with 250 volts A. C. or less.

In view of the number of fatal accidents caused by 220 volts A. C. in Sweden (calculated per million inhabitants connected at each voltage). Dr Alfred Ekestrom, M. I. E. E. considered it 'inadvisable, inspite of the technical advantage, to use the higher voltage'. New extensions in Stockholm are, therefore, being made at lower pressure (*The Electrician*, August, 1930).

"The safety aspect of the matter is clearly of cardinal importance. Most continental electrical engineers certainly regard 230 volts A. C. as much too dangerous for domestic and rural use. In Europe and North America also, less than half this pressure is generally used, and the gain in efficiency resulting from the adoption of the higher pressure is not considered adequate compensation for the increased risk. Even our own factory statistics point in the same direction. There has been a notable increase in the proportion of fatal accidents corresponding to the more general use of A. C. at or around the standard voltage. Failing the introduction of really effective control over wiring and appliances in this country there are about to be occurrences which will form useful propaganda for a rival industry, as the result of a large extension of domestic and rural electrification at 230 volts A. C.". (Have we chosen well? "*The Electrician*," March 6, 1931).

Thus in order to avoid fatal accidents, almost all the big cities of the world have adopted either 110 volts A. C. or 220 volts D. C. in preference to 220 volts A. C. Throughout France, the United States of America, Japan, Spain, and the whole of Manchuria, we find 110 volts.

Even in the *heart of the city of London*, business houses and numerous residential flats are being supplied with direct current at 100 volts (*The Electrical Times*, page 35, 11th January, 1934).

In the *Viceregal Lodge at Delhi, Governors' Houses at Calcutta, Patna, Lucknow and other places and even in important officers' quarters* the D. C. system has been adopted. Surely the supply companies fully appreciate the comparative value of human life in different classes.

In view of the facts and figures given above it seems almost suicidal to adopt 230 volts alternating current supply as the future supply voltage in India. Therefore, it seems highly desirable that public should strongly protest against the supply of 230 volts A. C. for domestic purposes.

Hindu University B. C. Chatterjee.
Benares.

On the Origin of the Raman Lines close to the Rayleigh Line due to some Organic Crystals

The Raman spectra of the crystals of diphenyl ether, naphthalene, *p* dibromobenzene and benzene have been studied recently by Gross and Vuks[1] and it has been observed that the wing which appears on both sides of the Rayleigh line in the case of the liquid state, is replaced by a few lines or bands in the case of the crystals. They have also observed that, on melting the crystals, these lines broaden out, and merging into one another, form a continuous wing. From these facts they have drawn the conclusion that the lines mentioned above are produced by the oscillations of the lattices of the crystals, and these oscillations persist in the quasi-crystalline groups present in the liquid, but due to the looseness of these vibrations in the liquid state, these lines spread out so as to form a continuous wing. According to these authors, the whole of the wing excepting the portion adjacent to the Rayleigh lines owes its origin to the lattice oscillations in quasi crystalline groups. This point of view can be tested by comparing the relative intensities of the Raman lines mentioned above with respect to that of the other vibrational Raman lines, and also by comparing their width in the crystalline and liquid states and also in solution in a solvent which itself gives practically no wing. In the solution the quasi-crystalline groups of the solute should be broken up and consequently, according to the hypothesis mentioned above, the intensity of the wing in comparison with that of the other vibrational Raman lines should be much smaller than in the case of the pure solvent.

The Raman spectra of diphenyl ether and naphthalene have therefore been investigated carefully in the crystalline and liquid states and in solution in cyclohexane. The wing due to cyclohexane is so feeble in comparison with that due to naphthalene and diphenyl ether that the wing due

to the solute alone could be recorded with proper density on the spectrogram due to the solution, the density of the wing due to the solvent being quite negligible. A Fuess spectrograph producing absolutely no coma on the Stokes side of the Hg line 4046° A was used. The spectrograms obtained with liquid diphenyl ether at 30°C and 180°C are reproduced in Figs. 1 (a) and 1 (b) respectively and that due to a 35% solution of diphenyl ether in cyclohexane is reproduced in Fig. 1 (c). The spectrograms due to naphthalene crystals and liquid naphthalene at about 110°C are reproduced in Figs. 1 (d) and 1 (e) respectively.

It is seen from these spectrograms that in the case of diphenyl ether, each of the Raman lines 70 cm^{-1} and 104 cm^{-1} observed in the crystalline state (the spectrogram due to

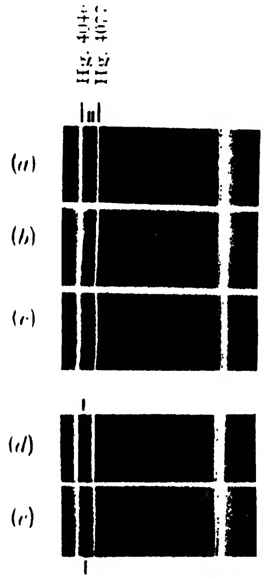

Fig. 1

crystals of diphenyl ether being rather feeble has not been reproduced here) slightly broadens out on melting the crystals but its width does not increase any further on raising the temperature up to 110° C. Also, at the higher temperature the intensity of the other portions of the wing *increases appreciably* and the relative intensities of these two lines with respect to those of the other Raman lines ***diminish only slightly***. In the case of the solution also, the width of these two lines remains the same as in the case of the liquid state at the room temperature. The relative intensities of these two lines compared to those of the other Raman lines, however, are slightly less in the case of the solution than in the case of the pure liquid, but those of the other portions of the wing remain unchanged. From these facts it can be concluded that the lines are only superposed on the wing in this particular case and their origin is quite different from that of the wing.

In the case of naphthalene, the intense line 73 cm^{-1} observed with the crystals becomes slightly broader in the liquid state at 110°C and it persists with its width unchanged in a 20% solution of naphthalene in cyclohexane, but in the latter case the intensity of the line compared to that of the other vibrational Raman lines is much less than in the case of the pure liquid, and that of the other portions of the wing is practically the same in the two cases. The line is however absent in a 15% solution of naphthalene in methyl alcohol, but the wing extends up to about 70 cm^{-1} though the wing due to methyl alcohol alone is even much feebler than that due to cyclohexane.

It appears from these facts that the Raman lines mentioned above are produced by the oscillations of small groups of molecules which are more stable in the case of diphenyl ether than in the case of naphthalene. In these particular cases the lines due to these oscillations are superposed on the wing produced by some other cause, and the general conclusion that the whole wing is produced by lattice oscillations in quasi-crystalline groups is not quite correct.

Results of further investigations and detailed discussions will be published shortly elsewhere.

My thanks are due to Prof. D. M. Bose for his kind interest in the work.

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27.9.35.

1. *Nature*, *135*, 100m 431, 998; 1935.

X-ray Study of Calosterol

K. P. Basu and M. C. Nath supplied us with some crystals of the sterol extracted by them from calotropis Gigantea and described in *The Biochemical Journal*, *28*, 1561, 1934. From goniometric measurements we found that the substance belongs to the ortho-rhombic class. This is interesting in consideration of Bernal's work on ergosterol and its irradiation products all of which have been found to be monoclinic except cholesterol which is of still lower symmetry and is triclinic. From rotation photographs the following dimensions were obtained for the orthorhombic cell:

$$a = 11.27 \text{ A}$$
$$b = 7.90 \text{ A}$$
$$c = 35.3 \text{ A}$$

The density measured by the suspension method was found for the densest particles to be 1.111. Taking for the number of molecules per unit cell the very plausible value of 4, we find the molecular weight to be 529. Combining the results of microanalysis of Basu and Nath, the formula obtained for the substance is $C_{[illegible]} H_{[illegible]}$.

The difference of optical behaviour of the substance as found by Basu and Nath is probably somehow related to its more symmetrical crystal class. A complete investigation of the crystal as regards its space-group and optical and magnetic properties is in progress.

K. Banerjee.
N. C. Chanda.

The Biochemical Relationship between Adrenalin and Vitamin C.

The possibility of a relationship existing between vitamins on the one hand and hormones on the other has often been discussed. The fact that there is a large concentration of both adrenalin and ascorbic acid in the medulla of the adrenal gland has naturally attracted attention to the question of a possible biochemical relationship between them. We have for some time been investigating this problem in three different aspects.

One symptom of scurvy is the tendency to capillary haemorrhage, and vitamin C has often been stated to function in maintaining the nutrition and tone of the capillaries. As adrenalin raises arterial blood-pressure it was considered of interest to investigate the effect of (a) ascorbic acid, (b) adrenalin and (c) adrenalin *plus* ascorbic acid on the blood-pressure of cats (anaesthetized with urethane or amytal). In a few cases only, the injection of ascorbic acid caused a slight lowering of the blood-pressure while the injection of adrenalin ascorbate (prepared by mixing equi-molecular proportions of adrenalin and ascorbic acid) produced a slightly greater effect (also in a few cases) than the injection of equivalent amount of adrenalin chloride. Working with twenty animals, however, uniform results were not obtained and it appeared, on the whole, that ascorbic acid does not markedly influence the pressure effect of adrenalin.

Secondly, it appeared interesting to investigate whether in scorbutic guineapigs along with the known depletion of the ascorbic acid of the adrenal gland there is also a concomitant diminution of the adrenalin content. It was found that, in scurvy, though the ascorbic acid content was reduced to nearly one-sixth of the original value, the adrenalin content of the gland remained remarkably constant. (Eight scorbutic and eight control animals were used). The adrenal glands were extracted with slightly acidified saline at 60° and the adrenalin was estimated physiologically, in view of the fact[1] that Folin's reagent, used for the chemical estimation of adrenalin, is also reduced by ascorbic acid.

Thirdly, it was investigated how far ascorbic acid would stabilize adrenalin *in vitro*. The comparative stability of adrenalin in presence of graded molecular proportions of ascorbic acid and of equivalent proportions of hydrochloric acid was, therefore, studied under identical conditions. It was found that, whereas a solution of adrenalin with one fourth its molecular equivalent of ascorbic acid would be stable for at least twelve hours, the same molecular proportion of hydrochloric acid would not prevent the solution of adrenalin from turning pink in 10 minutes under identical conditions of experiment. It is evident, therefore, that comparatively small quantities of ascorbic acid can stabilize adrenalin remarkably, as has also been observed by Abderhalden[2] and by Heard and Welch[3], and support is thus lent to the theory that *in vivo* at least part of the function of the ascorbic acid of the adrenal gland lies in stabilizing adrenalin. The fact that in scorbutic guinea-pigs the adrenalin content of gland remains fairly constant is probably to be ascribed to the persistence of small quantities of ascorbic acid which never entirely disappears from the gland before death.

B. C. Guha
B. Chatterji.
N. Das.
A. R. Ghosh

Biochemical Laboratory,
Bengal Chemical and Pharmaceutical Works Ltd.
Calcutta.
21.9.35.

1. Guha, SCIENCE AND CULTURE, *1*, 111, 1935.
2. Abderhalden, *Fermentforschung*, *14*, 367, 1934.
3. Heard and Welch, *Biochem. J.*, *29*, 998, 1935.

Function of Traces of Manganese and Copper Compounds in Plant and Animal Processes.

We are greatly interested in the letter of Prof. N. C. Nag (SCIENCE AND CULTURE *1*, 212, 1935,) in which he has stated that natural waters in sea water contain appreciable amounts of manganese compounds along with iron. Recent researches have shown that traces of manganese are of great importance in many animal and plant processes. The function of manganese has not yet been satisfactorily understood. But the recent researches of Palit and Dhar (*J. Indian Chem. Soc. 11*, 471, 661, 1934), show that addition of small amounts of manganese to ferrous hydroxide acting as inductor markedly accelerates the induced oxidation of glucose. Thus the oxidation of the glucose in presence of ferrous hydroxide alone is 4·33% and after the addition of 0·00328 gm of manganous hydroxide to ferrous hydroxide, the oxidation of glucose increases to 18·26%. Exactly similar results are obtained in the induced oxidation of glucose in presence of cerous hydroxide aided by manganous hydroxide.

We have also shown that minute traces of copper also stimulate markedly the induced oxidation of glucose and

other food materials. Traces of copper have also been found to be helpful in many animal and plant processes. It will be worthwhile to seek for the presence of copper in mineral and natural waters as well. It appears that the function of traces of manganese, copper etc. is to help the oxidation of food materials in plants and animals, and thus help their healthy growth.

Chemical Laboratory, N. R. Dhar.
Allahabad University, C. C. Balit.
Allahabad.

Synthesis of Diphenyl Derivatives as Intermediates for the Synthesis of 2-3 and 4-methyl 9-hydroxy Phenanthrenes.

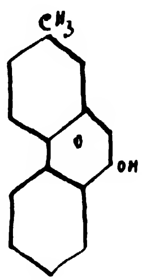
The present investigation describes the synthesis of diphenyl derivatives which are intermediates in the synthesis of phenanthrenes according to the method described by the author *J. India Chem. Soc. 12*, 591 ; 1935

4-Methyl cyclohexanone 2-carboxylic ester is condensed with ethyl chloroacetate when diethyl 4-methyl cyclohexanone 2-carboxylate 2-acetate (Bp. 165°/5 mm ; Semicarbazone M. P. 174°C) is obtained. This on hydrolysis yields 1 methyl cyclohexanone 2-acetic acid (Bp. 160°-165°/6 mm). After esterification (Bp. 129°/8 mm; Semicarbazone M.P. 210° 211°C) it is treated with phenyl magnesium bromide when ethyl 1-hydroxy 4-methyl hexahydro diphenyl 2-acetate (Bp. 168°-178°/7mm) is obtained. This on sulphur dehydrogenation and ring closure is expected to yield 2-methyl 9-hydroxy phenanthrene (I).

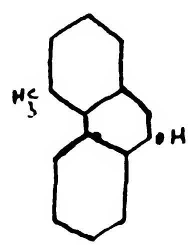
tion and ring closure is expected to yield 4-methyl 9-hydroxy phenanthrene (II).

In the preparation of diethyl 5-methyl cyclohexanone 2 carboxylate 2-acetate by Kötz and Bieber's method (*An. 350*, 243) it is observed that the product of reaction of 5-methyl cyclohexanone 2-carboxylic ester and ethyl chloroacetate is always contaminated with 2-methyl hexan 1. 5. 6. tricarboxylic ester formed by the ring fission. The boiling point of the above product recorded by us when the reaction is carried out in benzene in presence of molecular sodium is 163°-166°/5mm. Further we notice the following difference between Kötz and our compound.

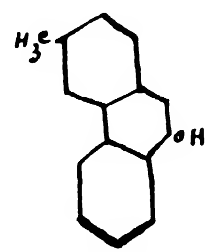
Kötz compound	Compound prepared by the author
Bp. 194°-195°/12mm	Bp. 163°-66°/5 mm
↓ on hydrolysis with methyl alcoholic	↓ on hydrolysis with cons HCl.
KoH 5 methyl cyclohexanone 2-acetic acid (gummy)	5-methyl cyclohexanone 2-acetic acid (crystalline) M. P. 94°-95°C
↓ esterified either through Ag salt or by HCl. method	↓ esterified by HCl. method.
Very poor yield of ethyl 5 methyl cyclohexanone 2-acetate (Bp. not definite due to poor yield Semicarbazone of this ester M. P. 116°C	Good yield of ethyl 5-methyl cyclohexanone 2-acetate. (Bp. 127°/5mm). Semicarbazone of the ester M. P. 174°-75°C



(I)



(II)



(III)

Similarly 6-methyl cyclohexanone 2-carboxylic ester gives diethyl 6-methyl cyclohexanone 2-carboxylate 2-acetate with ethyl chloroacetate (Bp. 158°-162°/8mm.). This on hydrolysis yields 6-methyl cyclohexanone 2-acetic acid (Bp. 162°-166°/6 mm). The ester (Bp. 125°-130°/8mm.) is subjected to the action of phenyl magnesium bromide when ethyl 1-hydroxy 6-methyl hexahydrodiphenyl 2-acetate (Bp. 160°.-170°/7mm) is obtained. This on sulphur dehydrogena-

5-Methyl cyclohexanone 2-acetate is then allowed to react with phenyl magnesim bromide when ethyl 1-hydroxy 5-methyl hexahydrodiphenyl 2-acetate is obtained (Bp. 165° 75°/7mm). It is expected to yield 3-methyl 9-hydroxy phenanthrene on sulphur dehydrogenation and subsequent ring closure.

Diethyl 4-5-and 6-methyl cyclohexanone 2-carboxylate

2-acetate when submitted to Grignard's reaction with phenyl magnesium bromide gives lactone of ethyl 1-hydroxy 2-acetic 4-methyl hexahydrodiphenyl 2-carboxylate (M. P. 112°C), lactone of ethyl 1-hydroxy 2-acetic 5-methyl hexahydrodiphenyl 2-carboxylate (Bp. 210°-220°/7mm) and lactone of ethyl 1-hydroxy 2-acetic 6-methyl hexahydrodiphenyl 2-carboxylate (Bp. 205°-215°C) respectively.

Further work in this line is in progress. The details of the above work will be published in the *Journal of the Indian Chemical Society.*

My sincere thanks are due to Professor Dr. P. C. Mitter for much encouragement and advice during the course of this work.

Sir R. B. Ghosh Laboratories, Nripendra Nath Chatterjee.
University College of Science,
20. 10. 35.

On the Distribution of the Ratio of two Samples drawn at random from Two Uncorrelated Populations of Pearsonian Type III.

Karl Pearson's original form[1] for the Type III distribution can be written as a gamma-function :

$$df(x) = C.\, e^{-ax}.\, x^{N}.\, dx \qquad \ldots\ldots\ldots\ldots\ldots(1)$$

where a and N are the population parameters and

$$C = \frac{a^{N+1}}{N!}$$

Let two uncorrelated Type III populations be represented by

$$\text{(i) } df(x) = C_1.\, e^{-a_1 x}.\, x^{N_1}.\, dx \qquad \ldots\ldots(2\cdot1)$$

$$\text{(ii) } df(y) = C_2.\, e^{-a_2 y}.\, y^{N_2}.\, dy \qquad \ldots\ldots(2\cdot2)$$

The joint distribution of x and y is given by,

$$df(x,y) = (C_1 C_2).\, e^{-(a_1 x + a_2 y)}.\, x^{N_1}.\, y^{N_2}.\, dxdy \qquad \ldots\ldots(3)$$

Let

$$u = \frac{x}{y}$$

where x and y are two random samples from the two populations.

For a given value of y, equation (3) may be written in the form,

$$df(x,y) = (C_1 C_2).\, u^{N_1}.\, du.\, e^{-(a_1 u + a_2)y}.\, y^{N_1+N_2+1}.\, dy$$

Integrating over y from 0 to ∞, we get

$$df = (C_1 C_2).\ (N_1+N_2+1)!\ \frac{u^{N_1}}{(a_1 u + a_2)^{N_1+N_2+2}}.\, du$$

Substituting the values of C_1 and C_2, the equation becomes

$$df = \frac{(N_1+N_2+1)!}{N_1!\ N_2!}.\, a_1^{N_1+1}.\ a_2^{N_2+1}.\ \frac{u^{N_1}}{(a_1 u + a_2)^{N_1+N_2+2}}\, du \qquad \ldots\ldots(4)$$

which is the required distribution of the ratio of two samples from two Type III populations.

It is interesting to note that, Fisher's Z-distribution[2] and Student's t-distributions[3, 4] are merely particular cases of the more general distribution given in (4). Fuller details will be published shortly in *Sankhya : The Indian Journal of Statistics.*

Statistical Laboratory, Subhendu Sekhar Bose.
Calcutta.
21.9.35.

1. Karl Pearson : *Phil. Trans, 180 A.*
2. R. A. Fisher : *Proceedings of Int. Math. Congress,* Toronto, 1924.
3. "Student" : *Biometrika, 6 :* 1 25.
4. R. A. Fisher : *Metron 5,* (No.3), 3 17.

Meteors- A Correction*

I would draw your attention to the manner in which you have added a paragraph concerning a recent meteoric fall near Comilla to my report on *Additional Stones from the Perpeti Meteoric Shower,* published on page 280 of the October issue of your valued Journal.

It must appear to your readers that I am responsible for that additional paragraph which contains the remarkable statement that the stones of the recent fall near Comilla "appear to be composed of iron and lead"; whereas, in point of fact, the paragraph has been formed from a report in the *Statesman* of the 2nd September, 1935, and has been inserted by you at the conclusion of my additional Perpeti report.

You, Sir, are no doubt aware that lead has never been found in meteorites in an amount sufficient for quantitative determination. Though traces of it are recorded from the

* We are sorry for the insufficient space allowed after Dr. Coulson's note. The paragraph beginning "following lightning and thunder" p. 280 forms a separate piece of news. We are glad to publish the above letter from Dr. Coulson for having drawn our attention to the error as well as for the scientific information it contains. *Ed.* SC. & CUL.

Collescipoli stone, Whitfield[1] was unable to confirm these. Native lead has been reported lining cavities in an iron from the Tarapaca desert of Chile; J. L. Smith,[2] however, concluded from his own observations that the metal was altogether foreign to the stone when it fell.

Accordingly, in order to dissociate my name from that remarkable statement concerning lead occurring in the recent Comilla (Patwar) fall, I would request you kindly to publish this letter in your November issue.

The stones recovered from the Patwar (near Nangalkot, Tippera district, of which district Comilla is the chief town) meteoric fall of the 1st August, 1935, will be described by me in a paper to be published in the *Records* of the Geological Survey of India.

A. L. Coulson.

1. G. P. Merrill, *Mem. Nat. Acad. Sci., Wash., 14*, No. 1. p. 14, (1916)
2. *Amer. Journ. Sci.*, *49* p. 305, (1870)

Common Script—A Correction

I am sorry I misinterpreted the writer of the article "*A Common Script*" in August 1935 of SCIENCE & CULTURE, when I stated in my letter appearing in October issue that the writer was of opinion that writing came into use in India in 300 B. C. The original sentence in the article runs as follows, "Before the discovery of Indus valley civilization the oldest method of writing which was found in the Indian continent was Brahmi....", which means that writing might have been in use earlier than Asoka's edicts.

Kindly oblige by inserting the above in the next issue.

Allahabad. Saligram Bhargava.
12. 10. 35.

In October issue, *read* Carnegie Institution of Washington *for* Carnegie Institute of Washington in the first article.

SCIENCE & CULTURE

A MONTHLY JOURNAL DEVOTED TO NATURAL & CULTURAL SCIENCES

Vol. I December 1935 No. 7

Public Supply of Electricity in India

In a previous editorial we gave a brief review of the history of development of the public supply of electricity with particular reference to the United Kingdom and the measures of control devised by the British Government for generation of electricity and its supply to the public at as cheap a rate as possible. It should not be thought that the United Kingdom is the only civilized country which felt the necessity of adopting these measures. Almost every civilized country in the world has come to regard the supply of electricity as a *public utility concern* and has taken steps for full development of its power resources, for adequate control of the production of electrical energy and for ensuring the public of a cheap supply and protecting them from profiteering and exploitation. The attitude of the Government of the United States towards this problem is thus summarized from the *Encyclopaedia Britannica*, 14th edition, 1929.

In the United States of America which is one of the most progressive countries of the world, electrical industry has had a most amazing growth, and today there is hardly a town with a population of over 1000 where electrical energy is not available to the public. *In the U. S. A., electrical industry is regarded as a public utility like water-supply, gas, railways etc.* Public utilities are generally monopolistic *i. e.* a particular concern has an exclusive right to serve a particular area. They are also allowed to make a considerable use of public property *e. g.* acquiring land, breaking up roads etc. where necessary. *In return of these privileges, the states assume the right of supervising and regulating the rates and standard of service of the utilities.* In the U. S. A. the Governor of a state appoints public service commissioners for a certain number of years. These commissioners, through whom the state control is really applied, have to assure the public of a safe and adequate supply of electric energy at a fair and reasonable rate. The public service commissioners have broad powers over accounting, financing, and over rates and service of the electric power supply companies.

Electrical Energy per capita --as a Measure of Civilization

We shall not deviate much from the truth if we say that the position of a country in the scale of modern civilization can be gauged by the amount of electrical energy available per head of its population. In this respect the hopeless backwardness of India will be realized from the table which gives the total production and distribution of electricity per head in different countries of the world. It has been compiled from the *Statistical Year Book* of the League of Nations for 1934-35.

Country	Population in millions	Total Electricity in million units 1925	Total Electricity in million units 1934	Consumption per head of population 1934
AMERICA :				
Canada	10·8	10,110	19,328	1788
U. S. A.	125·7	90,300	120,000	920
Mexico	17·2	1,262	1,606	97
EUROPE :				
United Kingdom	46·7	11,278	20,690	443
Germany	65·3	20,328	31,000	490
Sweden	6·1	3,673	6,050	1000
Soviet Russia	147·8	2,925	20,520	140
Bulgaria	6·1	32	137	23
ASIA .				
Japan	64·4	8,172	20,000	310
Java	60		231	4
Philippines		65	115	?
India	352		2,000	5
China	418		not known	
AFRICA :				
South Africa			985	

The above table does not claim to be very accurate, but it gives a fairly clear idea of the relative positions of the different countries in the production and consumption of electricity. Canada shows the highest consumption per capita, because on account of the existence of a large number of excellent hydro electric stations many of which have been fully developed, electricity has been rendered extremely cheap and is used as the prime source of power for railways, industries, and all domestic purposes. In Europe, the consumption of electricity per capita in Norway exceeds even that of Canada and for similar reasons. Next comes Sweden. Before the Great War, Sweden depended for her power supply on coal imported from England and Germany and did not pay much attention to her hydro-electric resources. But during the War, when the foreign coal supply was greatly reduced, the country had to suffer a good deal of privations; she then turned her attention to the development of her hydro electric resources. As a result of a few years' effort and by systematic and careful planning, Sweden has so much developed her water power that she is now practically independent of outside coal in all matters. Like Sweden, Italy and France too, which have poor coal deposits have tremendously developed their hydro-electric power resources.

The most interesting example is however furnished by Soviet Russia, where, in course of one decade, the power developed has increased nearly seven times. It is the result of systematic planning by the Soviet Government, who carried into effect Lenin's pet idea that the whole country including rural areas should be supplied with cheap electricity in Russia, that the work is increasing at such a tremendous rate. It is now expected that within a short time her consumption per capita will reach that of countries like England or Germany whose powers of development have almost reached the saturation point. Amongst Asiatic countries Japan has highly developed her water-power as she does not possess adequate supply of coal and oil.

Position of India

The total production of electricity in India according to J. W. Meares for 1,930 is 1300 million units. This figure probably does not include the electrical energy supplied by those schemes which have come into operation in recent years *i. e.* the Pykara, Mundi and the Ganges Canal hydro-electric scheme. But even after making liberal allowances for the electrical energy from these sources the total output up to date for the whole of India cannot at present exceed 800 million units. The consumption of electricity per capita in India is therefore a little over 5 units at the most. This is about 1/20 that of Mexico, a country which the public in India considers rather backward and 1/5 that of Bulgaria which is a very backward European country. This shows that in the scale of civilization India comes quite as low as China, or Abyssinia, as far as production of electricity is concerned.

Analysis of the Causes of India's Backwardness

We may now ask ourselves why the total production of electrical energy is so small. The reason may be (i) that India has no adequate power resources; (ii) that the resources exist, but for some reasons have not been developed; (iii) that the existing laws relating to generation and consumption of electrical energy are such as to retard growth of the industry.

The first alternative can be at once ruled out, as according to competent authorities there is plenty of power resources in India. The raw material for electrical power is either coal, oil, or running water. When coal is available at a cheap rate, nothing can be better; for the initial charges of setting up the machinery is small compared to those for hydro-electricity. But where coal is not available, attempt must be made for harnessing running water. Any head of water from 5,000 ft. to 10 ft. can be harnessed to yield electricity but the initial charges are very heavy though the running charges are comparatively low.*

Now India is a continent, and conditions differ widely in the different parts. Eastern India (Bengal and Bihar) has got rich coal deposits, while the rivers in the plains run through a flat country. Hence electricity is best manufactured in this region from coal, and this is the method adopted by the Calcutta Electric Supply Corporation and most other concerns in Bihar and Upper India. But certain amount of water power is available in the Himalayan regions, in Assam, and in Chotanagpur hills* which have neither been surveyed nor developed.

* At Darjeeling, there is the oldest hydro-electric plant in India giving a power installation of 1,000 kilowatts. Shillong is also served by electricity from running water.

Southern and Western India

Neither Southern nor Western India has much coal. But this is compensated by their possession of magnificient hydro-electric power resources in the form of waterfalls and hill rivers whose water can be impounded in lakes at a high altitude; very little of this power has been developed. Mr. Meares calculates that in Southern India (probably excluding Bombay Presidency) total available power is 3 million kilowatts of which barely 1 lakh has been harnessed. Of these, the Cauvery Scheme accounts for 18,000, and the rest are provided by Pykara (21,000) and a few other minor schemes. The Cauvery Scheme owes its inception to the farsighted vision of the late Dewan Sir Sheshadri Iyer of Mysore who, acting on the advice of some American visitors to the Sivasamudram falls, boldly undertook the task of harnessing the power which was running to waste. The scheme was completed under the supervision of engineers lent by the Niagara Hydro-electric Power Company who, according to contract, were to train up Indian officers for shouldering the responsibility of running the concern. After 30 years' working, the staff is now entirely Indianized. Southern India has recently developed the Pykara scheme (full power to be developed 18,000 kilowatts); and a number of other hydro-electric schemes are being developed in the Travancore State (Palivasal, total power 9,000 K. W.).

* According to Meares (*The law relating to Electrical Energy in India*, 1933,) the cost of installation per kilowatt in Bengal amounts to Rs. 616; in Bombay, Rs. 1237. The Bengal plants use coal, Bombay is served by hydro-electric power. The Mundi (Uhl River Hydroelectric Scheme—see later) has the proud distinction of furnishing the highest cost of installation *viz* Rs. 3,500 per kilowatt installed in the whole world.

Western India has practically no coal, but in the Ghats there are magnificient water power resources which have been partially developed through the enterprise of Messrs. Tata & Sons of Bombay under three sister organizations. These are:

		Total power-installation
(1) The Andhra Valley Scheme	...	60,000
(2) The Tata Hydro-electric Scheme	...	60,000
(3) The Tata Power Company.		109,500

These harness in all 2.30 lakh kilowatts, producing about 310 million units in 1933-1934 (June).

All these works (excepting Pykara) which were planned by States and private businessmen are highly successful concerns yielding a fair return for the capital invested, and supplying a real need of the country. The rates are still high and the companies continue to make very large profits and an examination of the balance sheet shows that the companies would make quite good profit if the directors could see some way of substantially reducing the rates.

Upper India consisting of the United Provinces and the Punjab has no coal, though oil is being worked out on a small scale in the Punjab. So far the electric supply companies in these provinces have been manufacturing electricity from coal, imported from Bengal and Bihar, and chiefly on this score, the companies are charging rates which are twice as high as Calcutta rates for electricity. We shall see later that the high charges are quite unjustified.

In recent years, a number of schemes have been put forward for manufacture of electrical energy from hydro-electric power resources in the Punjab and U. P. The best known amongst these schemes is the Uhl river scheme (known also as the Mundi Scheme) worked out by the late Col. B. C. Battye and opened by H. E. the Viceroy in 1933. The second is the Upper Ganges H. E. Scheme which has been worked out by Sir William Stampe, chief engineer, hydro-electric circle, U. P. We shall discuss this scheme in a subsequent issue of "Science and Culture".

The Uhl River Scheme

The Uhl river (in the Mundi State) scheme was, even before its inception, rather adversely criticized by many competent authorities including Mr. Meares, chief engineer, Hydro-electric Survey of India, and was the subject of two debates in the Punjab Council. But in India somehow the wrong horse gets the backing, and Col. Battye got the support of people in very high position, and was able to get his scheme sanctioned by the Punjab Government. It was first given out that the scheme would cost barely over two crores of rupees, but like many other schemes over which the public does not maintain a close watch, the cost went on increasing and every year the unfortunate Punjab Government was asked to vote more crores; when the cost piled up to over 6 crores and there was no sign of electricity coming within easy reach of the people, even the apathetic guardians of public finance felt doubtful about the scheme and got a committee (under the chairmanship of Major Howard of the Pykara scheme) appointed. This committee like many other Government committees said that, as so much money had already been spent in building railway lines and a fine hill station, the Government might spend a few more crores for hydro-electric work proper and bring the scheme to completion. So the total expenses came to very nearly 9½ crores and if rumour is to be believed, the supply on which the scheme was based has proved to be rather insufficient as foreseen by Mr. Meares, and for the major part of the year electricity would be manufactured from coal.

The above short sketch gives an idea of the present position of manufacture of electrical energy in India. Sir M. Visheshwarayya, the late Dewan of Mysore under whose regime the Cauvery Scheme was brought to completion states in his new book, *Planned Economy for India*, that the total potential power resources of India are 20 million kilowatts of which less than 3 per cent is at present developed (total 6 hundred thousand kilowatts). If this power were developed up to 50%, the total production of electricity would amount to about 80,000 million units and per capita consumption would be about 230 units. Sir M. Visheshwarayya proposes that a comprehensive scheme should be

put forward and 50% of the potential power should be developed in the near future.

Cost of Electricity

The question of electric charges was touched in our editorial of the previous issue and a table showing the comparative charges per unit of electrical energy for some English towns and two Indian towns was given. From the table it could be seen that the rate at Calcutta was about eight times greater than that at London and the rate at Allahabad, which we can take as a typical middlesized Indian town, was also about 5 to 6 times the rates charged in similar towns in England.

The electric supply companies in India enjoy several special privileges over the supply companies in England. A large number of supply companies were started near or during the war or during the immediate post war period when there was a boom in the industry and prices were soaring high. The result was that the maximum rates fixed in the licenses granted to the companies were fixed too high. But inspite of the changing economic conditions and the improvements in the generating machineries (lessening the cost of production) these rates have not been revised. Secondly, unlike the English supply companies, the supply companies in India have rarely to face any competition from gas supply companies except in one or two of the largest cities; and here too, electricity has a free field as far as the domestic supply is concerned. Thirdly, in India, the general rate of salaries of skilled and unskilled workmen and the lower cadre of employees in the technical departments as well as of the clerks and other employees in the general departments is much lower than that of men in corresponding positions in England.

The electric supply companies are public utility concerns and as such they enjoy monopolistic rights. It is therefore but fair that the companies should give the full advantage of all the privileges they enjoy to the general public. Instead of that they run their business in a purely profiteering manner and exploit the public as much as possible. Stray agitations in different cities of India have been made from time to time without achieving any substantial result. Recently the appointment of a committee to enquire into the charges of the Calcutta Electric Supply Corporation, has drawn the attention of the public to the affairs of this concern. The Indian Chamber of Commerce, Calcutta, has pointed out that the Supply Corporation has declared dividend as high as 13% for the last three years and has also built up a large reserve. The depreciation charged is also too high. Taking these and other relevant factors into consideration, the Indian Chamber of Commerce comes to the conclusion that the flat rate to the domestic consumers at Calcutta should not exceed about one anna per unit. The Electrical Engineer of the Calcutta Corporation, in his report on this question which has been endorsed by the Chief Engineer, has advanced a number of sound arguments as to why a much lower rate should be charged at Calcutta for the domestic supply than the rate prevalent at present. The average price for private supply at Sheffield, Glasgow, Manchester and Birmingham ranges between 1 to 1·8 d. It should be noted that the price of coal at these places in England is not lower than the basic price of coal assumed by the Calcutta Electric Supply Corporation for deciding their rates. The Corporation of Calcutta have drawn up a scheme of generating and supplying electricity for their own consumption in various departments. According to this scheme the average cost per unit is estimated to be about a quarter of an anna only. It is clear, therefore, that there is a strong case for a large reduction, specially for domestic supply. In other towns of India, the case for a reduction is much stronger.

Ecology of man in the Sunderbans

G. C. Chatterjee.

Scientific men try to explain the various phenomena of the living world in many ways of which some are as follows :-

(1) Tracing the evolution of higher types of living creatures including man from the lowest unicellular organism.

(2) Finding out the explanation, why some types of living beings are predominant at one period of earth's life, why they are extinct now, why development of some of the organs of defence, offence, locomotion and propagation, are explainable in an intelligent way by one law which has been designated as *Survival of the fittest or Struggle for existence.*

(3) Finding out, why certain types of organisms are associated with certain topographical conditions of the earth's surface and association with other plants and animals--the science of ecology.

(4) Tracing the evolution of modern man with his multifarious implements, for locomotion, defence or offence, from the primitive man who had none or had just adopted the stone implement for grinding his corn or cutting the wood--the man of the stone age.

(5) Tracing the various types of cultures of man some of which are extinct, some leaving their influence on the present culture. The Egyptian, the Phoenician, the Maya, the Aryan, the Greecian, the Roman or the Semetic etc.

It has been found that the peculiarities of some of the cultures owe their origin to the peculiarities of place of origin of the culture. The Phoenician and the Greecian originated from the sea coast, Aryan from oceanless Central Asia, the Vedic from the Indus, and so on.

The differences of pigment which characterize three main types of races of the world having different cultures, the albino which characterizes the Europeans, the yellow color which characterizes the yellow race, and the dark pigmented skin which characterizes men of the Tropics owe their origin to the action of actinic rays of the sun. These characters are however permanent and do not change by residence.

Hilgard the great soil expert of America noted a type of civilization associated with land having limestone predominant in its composition, which favours the development of plant world. Reverse has also been noted by him, namely favourable environmental surroundings, producing abundant vegetation to be found in the Tropics which he attributed to the activating action of heat of the sun on the nitrifying soil organisms. This has produced an indolent race in the Tropics. Unfavourable circumstances on the other hand causing difficulty in growing food grains due to retarded action of nitrifying soil organism and due to cold climate, have made men undergo arduous labour to obtain food; and this has made the hardy and adventurous European nations of today.

Besides, even now, the effect of surroundings is seen in the men of the hills differing from men of of plains. This effect of environment is even seen in the action of the different seasons of the year on living world. In some season (autumn in the temperate climate and summer in the Tropics) there is retardation of functional activity, while in another season (spring in the temperate climate and rainy season in the Tropics) sudden increase of growth takes place—some think due to pH value of the land water being at its optimum at this season. Effect of this we see in the annual rings in the cambium layer of dicotyledon plants and in the rays of the fins of the sea fish by which their age can be determined.

This seasonal influence affects all life in land and also that on the surface-layer of the sea. In the region of the sea-shore where due to attraction of

the sea by the moon and the sun, tides are produced, which passing to the coastal regions submerge the adjoining lands for a certain number of hours and leave them high and dry for a similar period. The denizens of this region of sea-shore "which can be defined as the strip of earth's surface between the highest land wetted by the sea and the lowest low tide mark, are exposed to greatest fluctuation and have the most variable condition of life in the completest contrast with the seasonless, dayless, changeless depths" of the ocean.

Biologists have described the various devices which the animals inhabiting this region of fluctuation between submerged and dry land, adopt to maintain their life during their 12½ hours of submersion under water if they be land animals, and during the 11½ hours period of dryness, in the case of water animals. The vegetable kingdom has also developed similar devices for living in this land of constant change; in the mangroves for example, the young plant germinates out of the seed, while in the fruit stage, before it separates from the parent plant, gets provided with a spine, so that when it falls on the seashore, it can anchor itself in the mud and can develop there before the coming flood tide submerges it.

Another class of biologists are engaged in studying how the marine animals adapt themselves in this region where sweet water from the rivers mingle with the sea water, and also how the sweet water animals adapt themselves when they come in contact with varying dilutions of sea water.

The wide belt of the Sunderbans traversed, as it is, by big arms of the sea from below which is the seat of ceaseless tides and by the numerous big sweet channels coming from above, offers an abundant field for study in this line. This place also offers field for study how human being, roaming about in the dense forest, with an axe in hand "daring to penetrate this pestilential haunt of smugglers and wild beasts" tries to find out a livnig by cutting wood, or by gathering honey out of the comb of wild bees, or by catching fish in the wide creeks with occasional chances of himself being caught by the tiger prowling about in the jungle or the crocodile infesting the creeks, later on succeeds in making a thriving village out of the waste lands. There is a field for study also, how the social and religious systems develop out of nothing and how the land tenure system, developes out of the right which first accrues to the maker of the settlement (*Abad*) and who is therefore called the *Abad-kar*. How this right passes down gradually to his tenants and how gradually the neighbouring zamindars spread out their arms claiming proprietory right over his land, while on the other hand the Government spreads out its still longer arms to claim this right, and how tenancy system developes out of this wrangling, are things of study for those who are engaged in the study of human institution connected with land from the earliest dawn of history. This they will find here in the making. This is not however the subject of this paper.

The subject of this paper is how these waste lands converted into thriving settlements by human labour showing evidence of civilization later, are going downhill again, and how they are becoming waste lands once more.

As this is occuring on a whole sale throughout the area in the coastal regions of 24 Parganas, Khulna, Backergunge, Midnapore and also of Orissa, the ecological condition which is producing it is worth studying. Before doing so, it is necessary to mention that life of human being here is devoid of all the amenities of life, not to speak of luxury. They cultivate the land for rice which is the only thing to grow here, (in 92 p. c. of the cultivated land is grown paddy) and catch fish from the numerous creeks. A few essential requirements such as clothing, umbrella, shoes etc. are got from Calcutta with the money realized from the sale proceeds of the fish and rice. The land in which they live, and cultivate rice, being low and liable to submersion by salt water of the flow tide, ring bunds are made around the *abad*. At the mouth of small channels around the settlement which intervene between two plots of land, a sluice with automatic doors (which close in flood tide but open during low tide) is placed preliminary to every settlement. If accidentally the ring bunds are breached the crop is destroyed within a few hours and then starvation stares the poor cultivators in the face. If this occurs in several of the *abads*, due to a common

cause, such as flow tides of exceptional severity, wide spread famine results. Then their only way of finding out a living is to resort to a subsidiary profession of cutting wood in the Government reserved forests. The profit out of the sale, after paying Government dues and middle man's profit, can anyhow keep their body and soul together.

It is to be noted that in most of these places where this breach of the bunds occurs, the immediate cause will be found very often in the boring habit of some of the animals (crabs etc.) infesting these places in millions. But if one takes a broader view of the whole situation, the cause will be found to be the growing height of spring tides for reasons to be explained later on. At one time a negligible embankment of not more than 2 ft. was necessary to keep off saline water while it has to be raised now fully to a rampart 10 ft. high to protect the settlement from the inroads of the sea. This has to be done not only all round the settlement, but subsidiary embankments between one portion of the same settlement and another, as also endless lines of bunds, in place of old rejected ones which have partially been engulfed by the creeks, have to be made. For creating these, digging of earth out of the already low land has to be done,—so one can imagine without going there the conditions of the place, a country not of scanty rainfall, but of severe rainfall,—especially if the creeks coming out of the settlement and acting as drainage channels get silted up.

Even if the malaria-carrying variety of mosquito does not get a chance of sending its offsprings from the surrounding malaria-stricken places of Bengal and even if malaria suffering man does not go there, the extent of waterlogging which happens is sufficiently harmful. In fact, one of the crew of the steamer in which we were travelling, looking on the veritable hell of one of these settlements, told us that even the cows had to be protected by mosquito-curtains from being bitten by the mosquitoes which bred in these places.

Lastly to complete this picture of abject misery of human being, if the above be not enough, it is necessary to add the information about the peculiar land tenure system which prevails there. The absentee landlord realizes Rs. 2/- to Rs. 3/- per bigha from the tenant, paying to Government annas -/8/- only, with right to get one fourth the sale money of the land, if the cultivator wants to get out of this hell by selling it, or 5 times the rent,—whichever is higher. This system worked tolerably well, when the land yielded 12 mds. of paddy per bigha and its selling price was Rs. 4/- per md. When now the land due to decreasing yielding power, is giving 6 md. of paddy and the price of paddy is Re 1/- per maund the rent remaining the same as before, one can see by a little mathematical calculation, whether this place is the El Dorado, which our young unemployed educated people, should elect for a living, when the type of people, who are derelict even among the cultivators, cannot get a living and do not know how to part with their land in the making of which they have shed their life blood so to say. The zamindars and the Government are busy drawing out rules and regulations and enacting numerous acts in the Legislative Council for establishing the revenue system and also ascertaining how much the zamindar, and how much the Government should get out of the produce of land, but there is none to help the cultivator to make him increase his yield. Every one would be busy to get his own share of milk out of the milch cow, but none would take care of the cow, or feed her.

Now, I proceed to discuss the cause which is creating this catastrophe. As it is very difficult to visualize the actual condition on account of the vastness of the area affected and the complicated problem of tides and the huge amount of land formation going on due to enormous amount of silt brought down by the large number of rivers emptying here, it is best for one who has not much time to spare, to take a trip by the inland steamer service from Calcutta to Khulna.

Starting from Calcutta in the morning one will reach the Channel Creek in the afternoon (the main channel of the Hooghly through which the ocean-going steamers go out to the sea). This creek intervenes an island called the Sagore Island). Before reaching here, he will see in the left as well as in the right bank of the Hooghly numerous creeks in which large number of country boats are lodged. They cannot enter through these now as they used to do before. Thus the large inland traffic by boats of former days has stopped for ever. One will

find every where extensive embankments, all along the edge. The land inside here is not at all low, and there is hardly any chance of dangerous flooding, still since people cultivate rice down to the edge of the river, these bunds are made to prevent their paddy lands being flooded by brackish water. The land enclosed by the bunds are being raised and the small creeks are getting silted, due to the flood tide going in and out into the creeks. This tide does not get access into the low lands due to the bunds and the silt gets deposited in the beds of the creeks.

From the Channel Creek, one will enter a creek called the Doagra. It can plainly be seen there that this channel which is a broad one has to be dredged periodically by Government at an enormous expense to allow it to be used as a steamer route. According to Mr. C. Addams Williams, C. I. E., the late Chief Engineer, Irrigation Department, it is sure to get choked in time inspite of dredging. This will make the Inland Steam Navigation Company to seek another round about route to go to Khulna.

One will next reach Namkhana. Here he will find on both sides the worst possible result of premature reclamation. He will see long stretches of channels running through the settlement full of water which cannot get out. Even in the lowest tide, the land is waterlogged.

In the evening, he will reach Sapturmukhi and then pass through the Thakurani, Roy Matla, Gosabha, and the Roy Mongal. As night sets in, there is no chance of seeing anything here. On reaching the Attarabanki (Sunderban) and Feringee Khal in the morning he will reach western part of Khulna. The whole day he will pass through big tidal creeks, the Jaboona, Arpangsia, Malanchi and Sipsa. In all these, he will see the water is comparatively free from silt and much of the salt, that the bath rooms of the cabins which are provided with water from the river by a pump worked by the engine of the steamer, are not filled at all. Here he will find very little of settlement, only the dense reserved forests on two sides will be seen. He will observe here high tides going into the interior of these jungle lands through innumerable meandering creeks. One or two country boats laden with forest produce will be seen. There being neither habitation of man, nor cultivation of rice, nor embankments, the tides can spill over the lands without any obstruction. Near the corner places, (the convex sides of the creek) due to deposit of silt, large recent formation of land will be seen, which being over grown by long grass, flocks of deer will be seen grazing. Occasionally a crocodile may be seen resting on the land, and plunging headlong into the creek on the approach of a steamer. Here the navigation is not so hazardous as in the creeks, the places being fairly deep. In many instances no place for anchorage for the steamers will be found.

In the afternoon he will reach Soother Khali. Here on both sides are settlements ; but as these are on already elevated lands, the state of affairs is not so bad as in Namkhana. In the evening, he will reach Passer and the Rupsah (Kachai bagha). There he will find the water full of silt and not saline, so the bath room pump starts working again. He will find on both sides large settlements. As the water is sweet, very little or no embankment will be seen. Evidence of enormous mass of sweet water coming from rivers above will be found. Enormous mass of water-hyacinth (coming from the Bhyrub) will also be seen. The settlements have all the appearance of healthy flourishing villages. Large number of small boats will be seen plying, carrying goods to the nearest huts. The people going from place to place for individual business use boats and not bullock carts. He will see, later on, a hut where buyers and sellers all come in boats, big or small, there being no bullock carts, no motor cars, no horse driven carriages anywhere.Then in the evening, he will reach the huge expanse of the Rupsah and then reach Khulna. Night sets in.

During the night's journey, the steamer passes through the Attye river which runs parallel to the Madhumati, to which it was connected by an artificial cut some years ago by Mr. Hallifax, a former Collector of Khulna. This cut has since increased very much in size on account of huge amount of water coming from the Madhumati—for the same cause the parallel broad river Atta has been made out of a narrow channel. Then the steamer passes through the Madhumati.

In the morning it reaches the Madaripur Khal. Though this paper is confined to consideration of

rivers and creeks of the Sundarbans and as this region is beyond Sunderbans and even beyond Khulna district, yet for reasons to be explained later, we will continue our description of this portion of our journey by the steamer. As soon as we started passing through this route which is a route made through a natural depression called Madaripur Bheels, we found huge onrush of water coming from north. This got blocked by the embankment of the route, and the opening provided for passage of water was also too insufficient. We thus found miseries of human life caused by too much supply of fresh water, whereas we saw in the first portion of our journey, miseries caused by defficient supply of sweet water. It is to be remembered that the source of supply of sweet water in both the cases is one river, namely the Padma which passes from west to east, bounding the northern portion of the division, from the origin of the Bhagirathi Hooghly to that of the Gorai Madhumati and right up to the Meghna.

Whole sale submersion of villages was seen from the steamer all through the day. On the narrow space of the bund of the bheel route, not more than 3 or 4 ft. broad, thousands of cattle were seen standing in a row. From this place onwards till we reached Gauhati, the place of our destination, we saw before us scenes of indescribable desolation every where. Boats were plying hurriedly from thriving villages carrying away the scanty household furnitures and utensils from submerged cottages. Even children were seen helping the parents in loading the boats. Big trees 50 to 60 years old were being hurriedly cut. Even parts of dismantled masonry buildings were being carried into the interior, the men trying to save as much of the material as possible from the mad onrush of the mighty rivers.

Now, to analyse what we see in our hurried cross country trip through the Sundarban, from the Hooghly to the Madhumati, let us divide it for the sake of convenience roughly into three parts. In the first part, from Doagra to Feringee Khal (whole of 24 Perganas and western part of Khulna), the settlements are in waterlogged condition and the creeks are rapidly silting. From this part up to Sibsa (Central portion of Khulna, the second portion of our journey) there are very few settlements and the creeks are broad and deep and are not silting at all and the water is saline. In the third portion, from Sibsa to Khulna, the settlements are healthy and not being waterlogged are free from malaria. Active life of the people as contrasted to listless apathetic life of the first portion was apparent even from the steamer deck. The explanation of this lies in the fact that in the first portion, owing to supply of sweet water from above, the settlements which have been formed there, have to put up embankments to prevent saline water getting into their land. The water of the creeks are saturated with silt, and the tides not being able to spill into the lowlying land, the silt is deposited in the beds of the creeks. The flow tides come through funnel shaped openings in the sea face, pass inwards finding no side space for spreading, and the height of the tides increases. The people on their turn increase the height of their embankment. In time the beds of creeks being gradually more and more elevated, the tides suddenly cease to pass into these beds. Again if the embankment breaches, the land becomes submerged. These cause intense suffering to people who cannot make out the reason, the cause not being a local one. In the second portion, in the upper part of the tract, are situated numerous natural depressions or bheels, into which the creeks spill during the flow tide; and on account of this spill not being encroached upon, the region of the creeks is at its best. In the third portion, huge amount of sweet water comes from above, and mixing with the tides make their water sweet. The people in the settlement do not put up embankment nor are the drainage channels situated in the interior of settlements sluiced. The settlements here are all open to free propagation of tide. In this way the low lands are being filled up and the creeks do not get choked, and there is ample boat route in the country of which the people take full advantage. Beyond the Madhumati, the excess supply of sweet water is ruining the area by disastrous flooding.

In some portions specially those tracts situated near Calcutta, where due to want of supply of sweet water, the condition of human beings is going from bad to worse, advent of a new factor has however contributed partially to ameliorate their condition and so is worth mentioning. The inhabitants of a part of this area have started a system of fishery which is peculiar to this country. Some natural depression in this area of tides,

which serves as spill area of the tidal creeks, is enclosed at the lowest portion by bunds, leaving sufficient opening for the tides to go in and come out. Across this opening fine meshed netting is put so that water can come in and out, but the sea fish which got entrance into the area in their earliest larva state, cannot come out. After a time, the whole of the water in the fishery is allowed to drain out through the exit during low tide—the fish trying to come out are caught in a system of traps placed near the outlet. The land is allowed to dry later on, and again next season the sea water along with its contents of fish larvae is allowed to pass in and then the netting is placed again.

As large expanses of the country are being utilized in this way—and this allows the people to have another means of income in addition to the cultivation of rice—and as this has the advantage that the people will have more inducement to allow entrance of saline water into land instead of absolutely excluding it as is done in the cultivation of rice, there will be less tendency for the creeks to get silted and will serve as efficient drainage channels and consequently as navigation channels as well. The "bheri" lands are also being elevated gradually.

This system is now being carried on by people without the guidance of any scientific man. As some of the fish caught in the traps are prized very much by Calcutta people (*Bhetke*, *Bhagon* and *Bele*), the owners of fisheries being absolutely ignorant of their life history, wholesale destruction of adult along with the fries of valuable edible fish takes place. The condition under which these fisheries can serve as breeding grounds of mosquito larvae, which later on when they take wings can add to the miseries of the people by causing malaria, is to be studied, which happily do not exist in most of these places. Besides, though this fishery system helps in providing spill for the creeks which rice cultivation does not, yet in certain circumstances, if the impounded water be kept too long and the tides be not allowed to get in and out, these will act in the same way as the rice fields by not allowing this impounded water to carry on the function of scouring the creeks, as has been pointed out by Mr. A. N. Banerjee, B.E. of Calcutta Corporation who has been quoted by Col. R. B. S. Sewell, I. M. S., Later Director, Zoological Survey of India, who apparently agrees with this view. So if a biologist succeeds in finding out the life history of the edible fish and their food and supports the idea that impounding water for a long period does harm to this industry, the owners of the fisheries can be easily induced to adopt the system of allowing free flow to the tides.

In England, France, Japan, United States, and Canada, the biologists are doing immense amount of good for the development of the country by imparting the laboratory knowledge to those engaged in estuary or sea fishery. Beyond studying a few cyclops, daphne, medusae, sea-anemones, and finding out how they develop in sea water diluted with sweet water, and ascertaining their various species the biologists of this country have not done anything to help this industry, no team work being carried on. Life history of a single edible fish of this country has not been worked out as yet, not to speak of the system of artificial fecundation which is carried out extensively in other countries, to increase fish supply in the estuaries, which is almost unknown to biologists of this country. One or two attempts made in this direction have ended in miserable failure.

If this knowledge be had, coupled with adoption of the latest method of refrigeration of fish by brine water cooled by liquid air and with better and quick transport (motor boats), there is a chance of diverting the peoples, energy from uneconomical cultivation of rice in low lands, which leads them to resort to system of sluices ruinous to the country.

Sometimes at the end of the last century an Englishman belonging to the Indian Medical Service, stationed in Madras, started research work on his own initiative to find out how malaria spreads from man to man. The hours he spent on this research work were stolen from his hours of duty and so there was a chance of losing his job. There was no grant from Research Fund in those days to help him. This resulted in the discovery of the Ross's malaria-mosquito cycle. This not only solved the malaria problem of many countries but led to finding of a new line of biological science. Based on this discovery, two different lines of work are being carried out to solve the malaria problem—

one, which is the more recent and on which many workers are engaged, is finding drugs synthetically which will have special action on the malaria parasite in human blood. Other workers are engaged in finding how to prevent the growth of the carrier which alone can solve the problem of malaria and has done so in many cases. As it breeds in water, there is a great field for the biologists not only to find the biological condition which will prevent their breeding in water but also to find out how to apply it to a vast concourse of human beings, living on the border line of starvation and on the border line of sweet and salt water who, not having the necessary knowledge or resource, carry on, living as they do semi-amphibiouslife, a type of agriculture favourable to the growth of mosquito and hence of malaria.

I conclude my paper by two quotations from a report by a Settlement Officer, which show that the danger is real and not fanciful.

"*Problems of Khulna river.* The problem of the rivers of Khulna is therefore two fold ; firstly, how to keep the rivers alive and secondly, how to keep the salt water or flood water out of the land, in other words the conservation of the river and the conservation of the fertility of the soil.

The first problem is pre-eminently in the sphere of the irrigation authorities ; but they have little concern with the second. The Revenue Officer is obliged to envisage both. The paramount object is admittedly to keep the rivers alive, for a moribund river is useless for navigation or for drainage, and breeds the fatal anopheline. The question seems to resolve itself into the adoption of one of the two alternatives, the extension of the spill area of the rivers, in order to free them from choking silt or reconnecting the dead rivers with a head water supply. Extension of tidal travel inwards is efficacious from the point of view of navigation, for the action of the tides ensures an adequate channel, but extension of tidal range involves the extention of salt water to the detriment of agricultural prosperity."

Dr. Bentley says in his treatise on *Malaria and Agriculture in Bengal*, "Briefly, it is the want of facilities for the egress and ingress of rain and flood water which is responsible both for a great decline of agriculture and the deterioration of public health which has accompanied it."

Fawcus says further : "Whether in time the genius of the Engineer will devise means for reflushing dead channels or the scientist will defeat the mosquito and other carriers of tropical diseases is a question we cannot answer now, but in the answer to this question lies the entire future health and prosperity of this district."*

*Read before the joint meeting of the Botany and Zoology Sections of Indian Science Congress, held at Calcutta in January, 1935.

Drug Adulteration and Spurious Drugs in India

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Introduction

That the market in India was being flooded by unscrupulous traders with drugs and chemicals of defective strength and impure quality and that potent remedies, such as sera and vaccines were being freely sold to the public without their quality being tested, were pointed out in the Council of State as early as 1927 by the Hon'ble Sir Haroon Jaffar. He characterized the practice as a great menace to the public health and called for the prompt institution of efficient safeguards to ensure the quality and authenticity of medicinal preparations offered for sale to the public. The discussion that followed showed an appalling state of affairs and the Council recommended to the Government of India to urge all Provincial Governments to take such steps as may be necessary to control this state of affairs. In the Legislative Assembly Col. Sir Henry Gidney stressed the fact that India was *par excellence* the dumping ground for every variety of quack medicines and adulterated drugs manufactured in all parts of the world and that her markets were glutted with useless and deleterious drugs sold by unqualified chemists, who were themselves a public danger. He pleaded strongly for the immediate introduction of effective legislation to eradicate the existing evil. The commercial community were also alive to the fact that a large number of chemists and druggists stocked drugs of inferior quality for sale and that this had adversely affected the pharmaceutical industry in the country. Public opinion expressed itself in no uncertain terms and medical and scientific journals took up the question. *The Indian Medical Gazette* described India as a "land of quacks, quack traders, and quack medicines". The leading newspapers like the *Statesman* vigorously championed the need for legislative interference to protect the masses from the perils of the situation. In response to this volume of opinion, the Government of India appointed a small *ad hoc* committee to explore and define the scope of the problem with reference to actualities and to make recommendations. Of this committee I was appointed the Chairman and I therefore had the opportunity of coming intimately in contact with the problem as it existed all over India, and received a large mass of varied and voluminous evidence, both written and oral. It heard a wide range of opinion on both the medical and the commercial sides of the problem. All aspects of the question were carefully and systematically considered. The committee found that the situation as described in the Council of State and the Legislative Assembly was not in the least bit exaggerated; in fact it was even worse and the committee called for stringent measures to cope with it. It is nearly four years since the Committee completed its labours and made its report. On account of financial stringency it has not been possible for any action to be taken and the position has not improved. It would in fact appear from various reports that have been published in the press from time to time in different provinces that things have gone from bad to worse. In Bombay spurious drugs with counterfeit labels having the names of well known firms have been seized recently (February 1935), and the Committee of the Bombay Chemists and Druggists Association has passed and forwarded to the Government a resolution of apprehension and great alarm of the overincreasing menace of adulteration of drugs prevalent in the country and of the frauds committed on the general public by unscrupulous dealers and fakers, to the detriment of the health of the public. A similar resolution reached the Government of India from an important body in the United Provinces last August and there is no doubt that

situation all over the country is the same. I can say from personal knowledge of Calcutta, which is one of the biggest drug trading and manufacturing centre in India, that the state of affairs is chaotic in the extreme and manufacturers of standard products are suffering heavy losses. I will now tell you briefly how different classes of drugs are affected.

The Quality of Drugs and Chemicals on the Market in India

Firstly, I will explain the extent to which the drugs and chemicals of the British Pharmacopoeia which are of impure quality or of defective strength are imported, manufactured or sold in India. This is the central problem as this group of drugs is the largest in use. There is unfortunately no room for doubt that in regard to adulteration, deterioration or tampering with the quality and strength of drugs, very little distinction could be made between imported and locally manufactured medicinal preparations. It is well known that firms abroad manufacture drugs specially for the Indian market and in the absence of control on the quality of drugs manufactured for export, these countries are able to undersell the local manufacturer of drugs. The dumping of inferior quality of drugs has its repercussion on the quality of drugs manufactured in India in which the quality is deteriorated to keep pace with the competitive rates of the dumped goods. A class of manufacturer has thus arisen who make and sell inferior and sometimes absolutely inactive products. Having regard to the seriousness and far-reaching character of the problems, the Drugs Enquiry Committee collected a large number of samples at random from different provinces and I subjected them to a careful analysis in my own laboratory. It was definitely proved that not only was adulteration common, but many firms sell packages which are considerably under-strength and under-weight. A perusal of the report of the Committee will show what a large number of preparations are involved. The medicinal preparations were found considerably below strength and instances were met where quinine was entirely omitted from quinine tablets.

This state of affairs is in no way altered since and there is no doubt whatever that the drugs on the Indian market at the present time are not above reproach and many of them are of impure quality and defective strength. I can say from personal knowledge that the traffic in such drugs at the present time is extensive and indiscriminate and the statements which have recently appeared in the press are in no way undeserved and exaggerated.

The second large groups of drugs are those which are not officially recognized by the British Pharmacopoeia but are known and approved medicines and are largely used. The extent to which such drugs of impure quality and insufficient strength are indiscriminately manufactured, sold or imported is the same as that of the Pharmacopoeial drugs. The groups of biological products include sera, vaccines, preparations from animal glands, hormones, etc.; besides these, there are complicated organo-metallic compounds containing arsenic, antimony, etc. Those imported into the country are frequently made by reliable firms of manufacturers having an established reputation. The climatic conditions and defective storage, however, may produce rapid deterioration in their potency and it is well known that many of the retail sellers have not proper arrangements for storage of these products. Some of the importers do not hesitate to descend to the vile practice of getting hold of time-expired biological products from the European markets and importing them into India and selling them to the dealers at a very cheap rate.

As regards those manufactured in this country, very few of the firms in India have the personnel and equipment to produce these products and therefore many of the preparations are not up to the standard. Unfortunately, complicated compounds of arsenic and antimony can be manufactured in India by anyone who may choose to do so and these potent compounds are being actually put on the market without their toxicity or strength being properly tested. Their standardization is at present left entirely to private enterprise and to manufactures and each maker is free to adopt his own conception of adequate standardization; there is no check whatever by the State. In other countries the toxicity of each batch of such complicated and potent preparations has to be carefully tested before they are allowed to be sold to the public. No licence is granted to any firm until the licensing authority is satisfied that the personnel and equipment of the

firm is qualitatively and quantitatively efficient for the purposes for which licence is sought. In addition to this licensing system, samples of finished products are tested by the laboratories under State control. While in other countries careful watch is kept over these potent compounds the Indian public is entirely unprotected. The position indeed is discreditable to the country and is a source of great danger to the public. I have recently tested some of these compounds whose toxicity is high and yet they are being sold to the public, one shudders to think with what consequences.

The third group of drugs we are concerned with are the patent and proprietary medicines. The Indian market is inundated with proprietary and secret medicines both imported and of Indian origin, and their sale is increasing by leaps and bounds. The public in India consume them voraciously on account of the ingenious propaganda, clever and alluring advertisement of their supposed virtues. The credulity and gullibility of the masses, especially when 'certain cures' are assured in utterly hopeless cases, can well be imagined. Perusal of advertisements of 'cures' produces a great effect on the patients who have tried treatment by medical men without success. The promise of cure, the force of argument advanced to guarantee it and the certificates of persons said to have been cured (who often do not exist at all) which are all set out in the advertisements make a deep impression. There is no doubt that while there are useful preparations among these there are also positively injurious and fraudulent combinations, and, on account of the lack of any State control in this country, their number is quite large.

The results of drug adulteration

The substitution of genuine medicinal products by rubbish has now reached a very serious stage and its results can be easily imagined. In the case of pharmacopocial drugs the patient to whom these drugs are prescribed will not naturally benefit by them. In diseases such as pneumonia, diptheria, etc., it may make all the difference to the life of the patient whether he is getting a drug of proper strength or an adulterated or useless preparation. In case of complicated organo-metallic compounds if they are not properly prepared and tested in a state of absolute purity, their use will be positively dangerous and fatalities may occur. In the case of biological products, incalculable harm may follow the use of products which are improperly prepared or stored. The injection of faked insulin on the market in cases of diabetic coma may lead to the death of the patient. The medical Research Council in England have described the absence of control over these products to be "a source of grave danger to the country." As regards the misery, breakdown in health and mortality that might follow the use of some of the patent and proprietary and secret medicines, cannot possibly be over-estimated. Much harm may result from the use of such medicines in negative as well as po ve ways. A patent medicine might be injurious and cause direct harm as some of he constituents may be positively dangerous in absence of control. Some medicines might have the effect of masking early symptoms of serious and grave diseases and assuaging them for a short period, resulting in the delay of scientific diagnosis and treatment. Much valuable time may thus be wasted and tigation delayed until it is too late to do a thing. It is for this reason that rigid control is exercised in many countries over extravagant claims made in advertisements, and the law prohibits statements which are untrue, deceptive, or misleading.

The remedy

How can the present unsatisfactory position be remedied. The Drugs Enquiry Committee has gone very carefully into the whole question and worked out a scheme by which control can be exercised on the medicinal preparations. This sceme has been generally accepted as being sound and effective. The essential parts of the scheme are firstly legislation, and secondly, machinery to collect and test drugs.

So far as the existing legislation is concerned there is no enactment in the Indian legislature which aims directly at the prevention of adulteration or which ensures conformity to proper standards of purity and strength. Certain sections in the Indian Penal Code, the Indian Merchandise Marks Act (1889) and the Sea Custom contain some provisions

bearing on it, but in actual practice they are difficult of application. The result is that mere adulteration of drugs is not by itself prohibited in British India by enactment. Nor is the sale of a drug of insufficient strength or improper standard punishable except on the basis of "misrepresentation" and 'fraud'. These expressions are vague and are of inconclusive import. The baneful results of adulteration or defective strength of drugs may be slow and gradual in making themselves evident. The non-existence of fixed standards or methods of analysis, the absence of any precise definition of adulteration, the want of skilled experts and of well-equipped laboratories, the difficulty of proof and the fact that intention or knowledge is the essence of these offences, as well as cheating, complicate the situation and render the provisions ineffective in actual practice. The Calcutta Municipal Act of 1923 and Bengal Municipal Act of 1932 deal with food and drugs in a fairly comprehensive manner ; the former defines the expressions "adulterated" and "misbranded" in relation to foods and drugs, but unfortunately, there is no machinery to work these. Most of the other provinces have some sort of lagislation. For proper control of drugs, however, there should be central legislation for the country as a whole, because that is the only way in which effectiveness and uniformity of control throughout India can be brought about. This part of the scheme does not need any monetary expense and could be proceeded with at once.

The machinery to test medicinal preparations consists of a well-equipped central laboratory with competent staff of experts in various branches as well as Provincial laboratories working under the guidance of the central laboratory. The provision for control includes the appointment of inspectors, who will be appointed by local governments to pick up specimens and send them to the provincial laboratories for testing. It will thus be seen that in any scheme of control the Central Government as well as the Provincial Governments must take part. This portion of the scheme is bound to cost money in the beginning though later on a good deal of revenue will be obtained. On account of financial stringency funds have not been forthcoming, with the result that we are now in the same position as regards the control of drugs as we ever were.

In all fairness to the Central and Provincial Governments it may be said that the problem in India is not so simple as it looks. The profession of pharmacy is still unorganized in India and the question of the purity of drugs and the profession of pharmacy are interdependent. The important part which the pharmacists play in relation to drugs needs no special emphasis. They are the custodians of drugs. They prepare, compound, and sell them, and on their efficiency depends the purity of the drugs dealt with by them. To ensure efficiency in discharge of duties and to guarantee that the drugs and medicines compounded, prepared, dispensed, or sold, are of proper strength and quality, it is essential that the pharmacists should be properly trained and under control. An untrained person cannot appreciate the value of scrupulous accuracy and the importance of purity and strength of medicinal preparation. In most parts of India at present anybody can compound and sell medicines. My Committee worked out a scheme for organization of those who practise it as a part of drug control. This is the only thing which will make them realize their responsibility, and thus help towards the disappearance of adulterated and spurious drugs.

Another problem which complicates matters in this country is the practice of the Indian systems of medicine and the drugs used by them. A very large proportion of the population, particularly in the villages and small towns, resorts to the indigenous systems of treatment and there is no doubt that many of the crude drugs as well as the compounded medicines offered for sale to the public are adulterated and of poor quality. Many of the practitioners in these systems use potent and toxic substances over which control is absolutely essential. It has been urged that if any legislation is undertaken for insuring the purity of drugs it should not be confined to drugs used by a small section of the population, namely those resorting to the western system of treatment only ; and one may be disposed to argue that legislation which aims at disposing the drugs used by western system only will be truncated and will lack in completeness or perfection. In the absence of standards, however, these drugs cannot be treated on the same lines as drugs and chemicals recognized by the British Pharmacopoeia and other western preparations. The only possible

way is to keep the drugs and preparations of the indigenous systems separate at present. Yet another difficulty is the existence of foreign territories and States in close proximity to the Provinces.

Such is the problem of adulteration of drugs and its control with which we are faced in this country. The problem is undoubtedly a difficult one, but a remedy must be found to rectifiy the present state of affairs. Although public health is essentially a provincial subject, food and drugs have not attracted the attention of local legislators to the extent they deserve. Drugs have fared worse than foods in this respect. I have already emphasized that no system of control in which the Provincial Governments do not take their due share along with the Central Government will be workable. Both must do their bit. An editorial in the *Statesman* recently under the title of "Keeping a nation fit" reviewed the report of the British Ministry of Health of which the control of drugs formed a very important part. It pointed out that expenditure on public health is a long-term investment and that purity of food and drugs is the first line of attack in the unceasing war against disease and epidemics. Those who have the control of the purse in this country should follow the lead given by Britain who has invested large sums of money on public health matters and is already receiving the dividend on the long-term investment. The Indian statesmen will, we hope, view this problem with the same breadth of vision as the statesmen in other civilized countries.

INDIAN SCIENCE CONGRESS

INDORE SESSION

The following discussions, which will be held during the meeting of the Indian Science Congress at Indore in January next, are announced in advance in order to enable those who may wish to take part to have an opportunity of preparing their remarks.

The following joint discussions have been arranged :

(*a*) *Agriculture* and *Medical Sections*,

'The Making of Humus and its Application';

(*b*) *Chemistry* and *Physics Sections*,

'The Structure of Molecules';

(*c*) *Medical* and *Physiology Sections*,

'The Problem of Nutrition in India';

(*d*) *Botany* and *Zoology Sections*,

'The Teaching of Biology in Secondary Schools'.

The following discussions, confined to single sections, have also been arranged :

(*a*) *Chemistry Section*,

(i) 'The Scope of Preparation of Fine Chemicals in India';

(ii) 'The Utilization of Molasses';

(*b*) *Geology and Geography Section*,

'The Classification of the Archaean Rocks of India';

(*c*) *Botany Section*,

(i) 'The Myxophyceae'.

(ii) 'Saltation in Artificial Cultures of Fungi'.

(iii) 'The Standardization of the Vernacular Names of Indian Plants'.

(iv) 'Chromosome Morphology and polyploidy'.

(v) 'The Importance of Anatomy and Taxonomy'.

University Life in Ancient India

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There are historical evidences that universities in the modern sense of the term existed at Taxila in the North-West (800 B. C.-500 A. D.), Valabhi in Kathiawad-Gujerat (500-763 A. D.), Nalanda (480-1199 A. D.), Vikramas'ila, and Odantapuri in Bihar, Jagaddala, Somapuri, and Vikramapuri in Bengal. There were also big colleges at Bodh-Gaya, Sarnath, Sanchi, S'ravasti, Kaus'ambi, Mathura, Bharhut, Nasik, Amaravati, Nagarjunikonda, Jagayyapeta, Kanchipura, Kaveripattana, and Madura. Dr. B. M. Barua* has also shown that there were some 84,000 smaller secondary and primary schools at the time of King Asoka. Rashdall has defined 'university' to imply a collection of teachers and students without any reference to a permanent place of residence.† Such a collection needed no doubt a place to assemble but there is a distinct difference between a school building and an assembly hall. Newman expanded the scope of the term by adding that 'university must include the idea of providing instruction to every kind of students.‡

The term, *Vis'vavidyalaya*, by which Indian universities are designated is more significant. It means a permanent place (*alaya*) of learning (*vidya*) of universal character (*vis'va*). Not merely this etymological sense, but the actual historical facts such as the corporate life of students and teachers in the same institution for a fixed period, the varied courses of studies and examinations, and the interchange of students and teachers in India and abroad, show the universal character of Indian universities. Further these institutions were maintained not only by the governments from public revenue but also from voluntary contributions by the general public as also from the countries abroad.*

It is true that all educational institutions were monastic in origin. Schools, Vidyalayas, and Maqtabas were originally attached to the church, the Ashrama or the temple, and the mosque. The school master was also the village priest, Pandit or Maulavi. The ideal of education was then cultural as opposed to the modern mercenary one. That culture was attempted to be achieved through the study of a group of ordinary subjects at the initial and intermediate stages. Even at the university stage the specialization was limited, and real specialization and research work started at what may be called the post-graduate stage. Despite the monastic character of ancient education, the real spiritual study was however reserved for a specially qualified few who were endowed with the proper inclination and aptitude

So far as Hindu India was concerned the child was left entirely free to grow till the age of five. Thence till ten he was brought under environments which leave impressions on the mind of a growing child. Between ten and fifteen, real control and influences were exerted for laying the foundation of

* *Introduction to Sridhara Barua's Bauddhapitha.*

† *Universities of Europe in the Middle ages. 1.6* (quoted by Mr. Sankalia in his *University of Nalanda.*)

‡ *The Idea of University* (P. 20) which also quotes from Walden : *Universities of Ancient Greece.*

* For example, a recently discovered copper-plate inscription of King Devapala (811 850 A. D ?) states that a donation was received for the Nalanda Mahavihara from King Balaputradeva, the Sailendra Emperor of Srivijaya (modern Sumatra and Java), with a request that the income of certain villages should be set apart for the maintenance of students at Nalanda University from the Sailendra Empire. The exact rendering of the inscription into English is that "Devapala (c. A. D. 814-850) at the request of Maharaja Balaputradeva of the Sailendra dynasty, the King of Suvarnadvipa (Sumatra), made a grant of five villages for the maintenance of a monastery constructed at Nalanda by that King and for meeting the expenses of the monks living there".

character building. From sixteen onwards, he was treated more like a friend and up to twenty-three he was allowed the freedom to think for himself under proper discipline. After this age, that is, from twenty-four onwards, he was again left to himself to grow as he had been till the sixth year of his life. The educational activities and the training of the body, mind, and character were thus confined to the period of some eighteen years between six and twenty-four.

Thus the schooling started at the age of six with what is technically called Siddha composition. The alphabet was learnt in six months, and a year and a half was spent on word-book. At eight, he started elementary grammar and finished by ten the second and third primers. At ten he took up the "Three Khilas" which may correspond to the three R's, comprising *Lekha* (writing), *Ganana* (Arithmetic) and *Rupa* (forms, Geometry and applied Arithmetic, calculation with coins, of interest, wages, and elementary mensuration). At thirteen, according to the Chinese traveller, I-Tsing, who visited India and resided for some years as a student at Nalanda, the young scholars commenced the "laws of the Universe and regulations of gods and men". This would imply elementary sciences, cosmogony, description of the earth, cosmic ages, exploits of gods, saints, and heroes, incarnations of Vishnu and geneologies of Kings. At fifteen, he is stated "to begin composition in verse and prose" of his own and during sixteen and twenty, he learnt "logic, metaphysics, Vedas, *S'iksha* (pronunciation), *Kalpa* (ritualistic practice), *Nirukta* (lexicon), *Chhanda* (metres), *Jyotisha* (astronomy), *Vyakarana* (analysis or higher grammar). At twenty, he studied further one of the new Vidyas—the *Trayi* (Triple Veda), *Anvikshiki* (Logic, Metaphysics etc.), *Dandaniti* (science of government or political science), *Vartta* (practical arts such as agriculture, commerce, medicine, etc.), *Atmavidya* (knowledge of individual and universal soul), *Dharma* (Law), *Purana* (History), and some of the sixty-four *Kalas* (Arts). The arts include such subjects as vocal music including everything from composition to singing; instrumental music of various kinds; playing on musical glasses or china cups containing varying quantities of water, on lutes and drums; dancing in various manners, styles, poses, and sentiments; dramatic and scenic art including acting; painting including the varieties of beauty, proportions, sentimental graces; colours and reliefs; making of beautifying articles such as powders, paints and tattooing; artistic arrangement of rice-meal, flowers and dishes; making of flower beds; staining of the teeth, dyeing of cloth, and colouring of the body; setting jewels on marble floor; bed-making; making of fountains; making of garlands; making of perfumes; decoration of body with ornaments and of house with furniture; cookery including cooking of vegetables, meats, cakes, foods to be eaten by chewing, sucking, licking and drinking, drinks including cooked and uncooked beverages both of toxicating and intoxicating nature; weaving and tailoring and making twist with a spindle or distaff; carpentry; sculpture; metallurgy; mining; making monograms, logographs and diagrams; jugglery; prestidigitation; tricks, gambling; playing with dice and rope; making dolls, physical exercises, and sports of various kinds*. The sports included hunting and other manly games as well as the lighter ones regularly practised not only for diversion from serious study but also for the display of skill and proficiency. The games are stated to have been once practised at the University of Nalanda "to keep the body and mind fit". The *Chullavagga* (I. 13. 2) specifies a list of games including 'elephant-riding, carriage-driving and swordsmanship, running in front of horses and in front of carriages, wrestling and boxing with fists, and spreading out robes as a stage and inviting girls saying, "Here you may dance, sister", and greeting her with applause.†

These long lists of subjects for study and games will no doubt prove the universal character of the courses of studies. The question would however arise if these subjects were regularly taught in any one institution. No university calendar has survived the deliberate destruction and not much remains have been found of the university buildings. But the excavations of Nalanda and Taxila by the Archaeological Department have substantiated in the main the descriptions of Chinese travellers. The

* For fuller descriptions of arts see the writer's article 'Fine arts', *Historical Quarterly*, p. 188-218, (1931).

† For fuller description of games see the writer's article "Universities of India during Hindu Period", *Twentieth Century*, July, 1935, pp. 1022-1023.

evidences of the Chinese travellers, many of whom actually studied as resident students at the University of Nalanda, are conclusive with regard to the courses of study they followed and the buildings they saw. The former corroborates the literary account quoted above regarding the subjects of study and exercise, and the latter is confirmed by the archaeological finds discovered after extensive excavation on the site of Nalanda.

According to Hiuen Tsang as recorded by his biographer Hwui Li, students in Nalanda study the great vehicle and also (the works belonging to) the eighteen sects, and not only these but even ordinary works, such as the Vedas and other books, the *Hetuvada* (logic), *S'abdavidya* (phonology), *Chikitsa-vidya* (medicine, magic, etc.), *Sankhya* (a system of philosophy); besides these they thoroughly investigated that miscellaneous works". Hiuen Tsang himself is stated to have studied at Nalanda *Yoga-S'astra, Nyayanusara-S'astra* (philosophy), *Hetu-vidya-S'astra* (logic), S'abdavidya (phonology and grammar), Kosha (lexicon), Vibhasha (languages), etc. from the famous professor S'ilabhadra and others. "Learned men from different cities", says Hiuen Tsang, "who desire quickly to acquire a renown in discussion, come here in multitudes to settle their doubts, and streams spread far and wide". "Thus instructed by their teachers", elucidates I-Tsing, "and instructing others they pass two or three years generally in the Nalanda Monastery (University) in Central India, or in the country of Valabhi in Western India (i. e. the University of Valabhi). There eminent and accomplished men assemble in crowds, discuss possible and impossible doctrines, and after being assured of the excellence of their opinion by wise men, become far famed for their wisdom."*

That Nalanda, Vallabhi, and other Maha Vihars were not merely Buddhist institutions dealing only with Buddhist scriptures and theology has been proved beyond doubt by the Ghosrawa Inscription. In it is stated that Devapaldeva received and patronized "a very learned Brahmin, Viradeva, who had come to Nalanda after visiting many centres of learning such as Kanishkapur (in Kashmere, reputed to have been founded by the Emperor Kanishka, 1st century A. D.), Yas'ovarmapura, etc. (*i. e.* the universities and colleges referred to above) and was afterwards *elected* the Head of the Sangha (*i. e.* the Chancellor of the university) by the assembly of monks (*i. e.* the Professors)."*

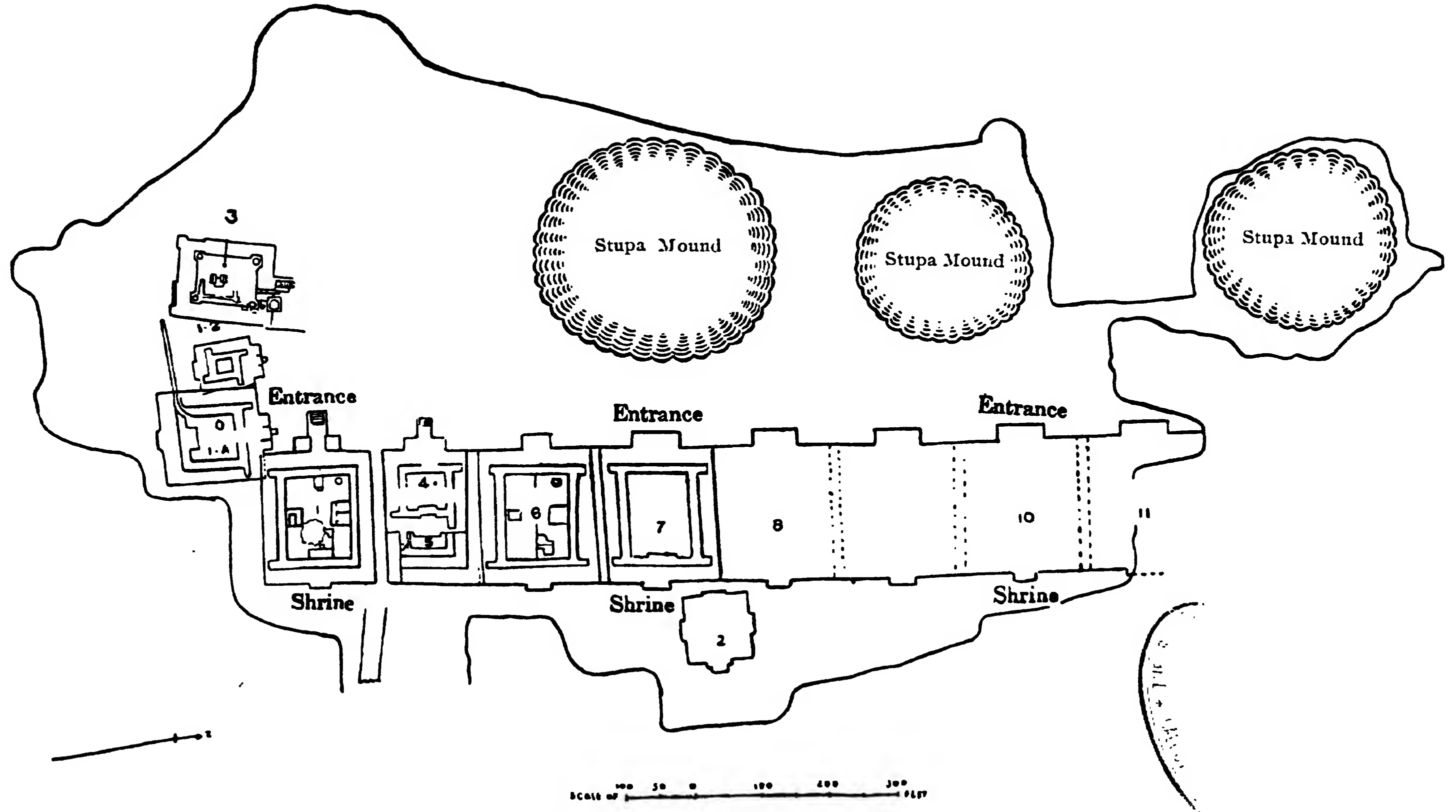
'Although theology was a compulsory subject even at the university stage, the *Adhyatma-vidya* dealing with the relation of individual and universal soul studied for the attainment of supreme knowledge could be taken up only by a few, specially endowed with necessary inclination and acquired qualification'.†

A vivid description of the University buildings of Nalanda is available. From the excavation and the accounts of Hiuen Tsang and I-Tsing, it is clear that "the University of Nalanda consisted of *Vihara*, *Sangharama*, *Dharmaganja*, and *Chaitya* buildings". There were colleges, halls, libraries, observatories priest's chambers, and quarters for professors, "nicely adorned towers, and fairy-like turrets", and other necessary and auxiliary quarters including "brilliant and magnificient memorials". "The whole establishment", in the words of Hiuen Tsang, "is surrounded by a brick wall. One gate opens into the great college, from which are separated eight other halls, standing in the middle". The *Sangharamas* appear from the excavations to have been built on rows and were three to four storeys high. I-Tsing testifies, and the excavations corroborate that there were at least eight to twelve colleges and over 300 rooms. The Tibetan accounts testify to the existence of a grand library, called *Dharmaganja*, comprising three grand buildings. One of these buildings was known as *Ratnodadhi* (ocean of jewels) and it was nine storey high and it stocked the sacred scriptures, *Prajnaparamitsutra* and the trantric works such as *Samajaguhya* etc. The other two were called *Ratnasagara* (sea of jewels) and *Ratnaranjaka* (illuminator of jewels), containing secular works and commentaries in connection with the various subjects and courses of studies. The priests' chambers were distributed in all the outside courts comprising four stages which had "dragon projections and coloured caves, the pearl-red (white) pillars, carved and ornamented, the richly adorned balustrades, and the roofs covered with tiles that reflected the light in a thousand

1. *loc. cit.* p. 1020.

*. *loc. cit.* p. 1021.

†. *loc. cit.* p. 1025.



1, 1A. 1-B Monastery. 2. Temple. 3. Stupa Site. 4-11. Monastery.

shades". In an inscription Nalanda is described as "a city which mocked, as it were, at all the cities of the Kings."*

Thus there need be no doubt about the existence of the specially built University quarters at Nalanda. Indeed, further excavations of the sites where the other universities and colleges existed are likely to unfold similar gorgeous buildings as have been unearthed at Nalanda.

Coming into the interior of the University we find a happy family of some 10,000 souls at Nalanda, all well-fed, well-clothed and well-looked after. There are epigraphical and other evidences that "large contributions were made to the University (of Nalanda) for its enlargement by kingly persons from Sumatra, Java, *Maloda* and *Tikima*, and by the Tukharians and a Gurjara-Pratihara King of Kanauj, Mahendra-paladeva (882-905 A. D)". The students paid for their own meals. The bedding and medicine were provided free from the voluntary contributions made by the visitors and the neighbouring villages. No charges appear to have been made for the residential rooms, nor was there any tuition fee. These charges and the salary of the teachers appear to have been met from the permanent funds supplied by the King. There are the accounts of the Chinese travellers as also the local historical evidences that the Nalanda University established by the Imperial Guptas received royal donations for about eight hundred years from all the reigning kings including Harshavardhana of Kanauj and the Pala Kings of Bengal and Bihar.

The students of the Hindu and Buddhist faiths had a sort of uniform dress, the former putting on "a garment made of hemp, linen, etc", and the latter even such "rich cloth as silk and wool, besides linen, cotton, and hemp". There were three kinds of robes, "one was a double waist-cloth, the other a single upper robe and the third was a single undergarment"†. The distinctive badge of the scholars of the Nalanda University appears, however, to have been a red cap known as the *Pandit's cap*. For home-life, a dhoti was common for both Hindu and Buddhist students, an *Uttariya* or upper garment for the former and a yellow rope for the latter. The general dress is corroborated by the accounts of Arrian, Nearchos and Meghasthenes. "The dress worn by the Indians is made of cotton. They wear an undergarment of cotton which reaches below the knee halfway down to the ankles, and also an upper garment which they throw partly over their shoulders and partly twist in folds round their head. Indians, as are thought any thing of, use parasols as a screen from the heat. They wear shoes made of white leather, and these are elaborately trimmed, while the soles are variegated, and made of great thickness to make the wearer seem so much the taller."*

According to I-Tsing, there were three meals served to the students at Nalanda. There was a sort of tea, consisting of rice water which was served soon after the sunrise when the student had finished his washing and cleaning his teeth with tooth-wood. The mid-day meal consisted of rice, butter, vegetables, fruits and sweet melons.† The evening meal soon after the sunset consisted of similar things but was more substantial in quality and quantity.

The relation between the teachers and the pupils appears to have been very cordial. The resident student's daily life at the University of Nalanda is described by I-Tsing.‡ "He (the student) goes to his teacher (tutor) at the first watch and at the last watch in the night. First the teacher bids him to sit comfortably. Then he gives a lesson in a way that suits circumstances, and does not pass any fact or theory unexplained. He inspects his pupil's moral conduct, and warns him of defects and transgression. Whenever he finds his pupil faulty, he makes him seek remedies and repent. The pupil rubs the teacher's body, folds his clothes, or sometimes sweeps the apartment and the yard". Students' duties towards the teachers are further elaborated in the Buddhist Vinaya Texts and the Hindu religious codes such as *Dharmasutra* of Gautama (Chap. II) and others. The pupils were considered as the teacher's sons, and no fees were demanded

* *loc. cit.* pp. 1019-1020.

† *Mahavagga* VIII. 10, I; I-Tsing: *Record of Buddhist Religion*. pp. 72-74 (quoted by Sankalia, *loc. cit.* p. 156)

* *'The Indika of Arrian'* translated in 'Ancient India' by J. W. McCrindle, 1877. p. 219-228.

† I-Tsing, *loc. cit.*, p. 44.

‡ *Record of Buddhist Religion,* translated by J. Takakusu, 1896, p. 120 (referred to by Sankalia).

of them. Just as the pupil was to be a nurse to his teacher when ill, so also the teacher nursed the pupil when the latter fell ill. Acts of immorality and transgression of ordinary rules of discipline gave rise to various regulations. For serious immoral acts expulsion was the highest punishment. For lesser offences various kinds of penances had to be undergone as specified in the Vinaya texts. But there was no imprisonment or birching as was the practice in Europe*.

The method of teaching proper can be gathered from the classification of scholars into four groups. "The group known as the *Padaparama* could do no more than to swallow everything they read. The group known as *Neya* was of slow understanding and had to be spoonfed step by step in order to make them understand, owing to their inferior intellect and power of grasping. The group known as the *Vipaschitajna* was of keener intellect and could follow learned teachers with a little elucidation. And the group known as the *Udghatitajna* was of an intellect of which as if the door had already been opened, and they needed no more than a mere guidance and hint : they could think for themselves ; they made their own researches and original contributions. There were thus required both tutorial coaching and mass or congregational lectures. The classes were never larger than of 100 students.

The aim of the education imparted is stated to have been to unfold the capacities of the individual student through proper means in order to make his life full of meaning for him as well as for the society. And in order to bring out the latent abilities of a student it was necessary to endeavour a harmonious development in his knowledge, work, and character. It was, therefore, required to have assistance from two classes of teachers. The *Acharya* was responsible for the teaching of all *Vidyas*, different Acharyas being placed in charge of different Vidyas or Departments of education. The *Upadhyaya* looked after the building up of student's character. The ordinary teacher is stated to possess at least twenty-five kinds of qualifications. He was required to look after the student all times and carefully in order to ascertain the good and bad habits of the student, his addiction and weakness, to provide for his rest and recreation, to know of his happiness and sorrow, to see if he had enough to eat and if his taste was satisfied, to distribute the good stuff properly, to encourage the student, to hold out hopes that his ambition would be fulfilled, to observe the working of his mind and his external movements, to warn him not to keep bad company, to remind his errors, and not to turn him out when he was in trouble, to keep a friendly heart for him, and to cherish a genuine fatherly ambition with a view to making him proficient in all possible Vidyas and an accomplished man'*.

Except for the foreigners of the status of Hiuen Tsang, the entrance and final examinations of the Nalanda university appear to have been very stiff. Those, seeking admission after the completion of the study at Kanishkapura, Valabhi or other colleges and universities had to pass through what is figuratively called six gate-keepers, which posts are expressly stated to have been held by the very learned professors. At the final examination held at Nalanda University eight out of ten candidates are stated to have ordinarily failed. 'For those who held the diploma of *Pandita* which was recognized by the King there were four kinds of examination known as *Pariksha*, *Upapariksha*, *Tulana* and *Gareshana*. *Pariksha* was the ordinary examination both written and *viva voce*. *Upapariksha* appears to have been a further test or chance on the basis of a student's day-to-day work, especially for those who were *padaparama* and could not pass the public examination and yet had to be given a sort of certificate for their general proficiency. The test on *Tulana* or comparison was a sort of debate in which the depth of knowledge, quick reply, and ready expression were compared among the intending debators, just as in the original Tripos examination in England. This type of examination appears to have been particularly noticed at Nalanda University both by Hiuen-Tsang and I-Tsing. The *Gareshana* or research was a test based on some written thesis by the advanced students†. The object of these examinations appears to have been

Rashdall, *loc. cit.* II. p. 609 (referred to by Sankalia)

* *loc. cit.*, pp. 1023-1024.

† *Ibid.* pp. 1025-1026.

to test a student's alertness, his power of comprehending new ideas, and his ability quickly and surely to assimilate to his own use, and his capacity to grasp a subject rather than to exhibit his mute and solitary reviewing and cramming of the prescribed books'. This needed two types of questions, the one type demanding "the knowledge," or more exactly, the power of re-stating facts and arguments of a kind that may be learnt by rote, and the other type demanding "the power of doing or writing something like a composition". Thus questions had to be set for written examination "requiring short answers to test the range of candidate's knowledge" and those "requiring long answers showing constructive skill and mastery of the subject and testing, the candidate's powers of co-ordination and reflections"*.

Thus the University life in ancient India does not appear to have been inferior in any essential respect even to the modern Western Universities. The so-called introduction of University education to India from the West is an irony of fate. Owing chiefly to the foreign administration long before the British came, the system had died out altogether. Thus there was need to establish the earliest universities like that of Calcutta after the model of London University, "mere Board of Examination to select clerks and assistant officers". The later reconstructed residential and teaching universities have been so many bad imitations. The main idea of cultural achievement through the study of art and science and character-building has been altogether lost sight of, and intellectual giants are being turned out. In the west the church ideas, if not the religious ideals, still dominate the university life. There is a church in every college. The robes, hoods and caps which we exhibit at our Convocation ceremony are monastic dress. We have, however, entirely forgotten the religious idea concealed within this dress. The practice of religion has been entirely turned out of the school rooms and college halls, not to speak of the university lecture theatres and hostels. There can be no church, temple or mosque associated with our school, college or university. Nor is there any real religious atmosphere in our modernized or Europeanized families who lead the society at large. That is, however, not the case in the western educated families in West. One wonders where this irreligious university life would lead us to. May not the intellectual gaints ponder over this matter while discovering ways and means to remedy unemployment, discontent, terrorism etc.

* *loc. cit.* pp. 1025-1028.

Light in the Prevention and Cure of Diseases

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In recent years our conception of the occurrence of disease has undergone a profound change. Thanks to the memorable researches of Pasteur, Koch, Lister, and others, the germ theory of disease was well established at the end of the nineteenth century and every disease was attributed to some bacteria. Later on, came the researches which established the fact that some diseases are caused by parasites or protozoa. In other words, till the end of the last century it was generally believed that most diseases are caused by some bacteria or parasite. The bacterial or parasitic theory of disease was so much trusted that Metchnikoff spent the last few years of his life in search of the bacteria causing diabetes and he expressed the view that there are many common features in diabetes and syphilis and that diabetes must be of bacterial origin.

The strong position of the bacterial theory of disease has been modified by the researches on vitamins. From experiments on birds and animals when fed with chemically pure fats, carbohydrates, proteins, and salts, it has been established by Hopkins, Funk, Mc. Collum, Mendel, and others that healthy life is impossible under these conditions and in order to maintain health, some naturally occurring food materials must be added to the chemically pure fats, carbohydrates, proteins, and salts. The great Dutch medical man Eijkman showed from his experiments on prisoners when fed with polished rice that beri-beri is caused in man from the lack of some portion of naturally occurring foodstuff. The material the absence of which causes beri-beri is the polishing of the rice ; when the polishings are added to the polished rice the disease beri-beri is avoided. This was the first instance of a disease which was definitely attributed to the lack of the right kind of foodstuff. Other researches followed and now we have a group of diseases known as "deficiency diseases," caused by the absence of vitamins or very small amounts of substances associated with naturally occurring food materials. Beri-beri, rickets, osteomalacia, pellagra, and sprue belong to this class of deficiency diseases and can be prevented or cured by the addition of the proper vitamins which occur in food materials.

It was believed from a long time that rickets which is now known as a deficiency disease and the occurrence of which leads to defective bone formation in children can be treated with light. In this connection it is interesting to note that rickets are not common in poor, tropical countries like China and India, although the food supply is inadequate from the vitamin and other points of view.

The writer of this article has emphasized that besides rickets, other deficiency diseases like beri-beri, sprue, night blindness, pellagra, osteomalacia etc. can be successfully treated with sunlight. Moreover, metabolism diseases like diabetes, gout, pernicious anaemia, and even cancer are amenable to light treatment.

So far we have been discussing the beneficial influence of light on deficiency and metabolism diseases. Now let us consider what the position is regarding the influence of light on bacterial diseases. Finsen may be looked upon as the father of modern light therapy in the treatment of bacterial diseases. He began his pioneering work in 1893 and achieved great success in the treatment of lupus, a tubercular skin disease difficult to cure. Over 1100 out of 1200 cases greatly improved on light treatment.

The next important step in light therapy was taken in 1903 when Dr. Rollier established a sanatorium at Leysin in Switzerland for the treatment of tuberculosis by sunshine. Dr. Rollier's name is

known throughout the world as the saviour of lives of thousands of people who had been declared incurable due to tuberculosis of bones. Hence Dr. Rollier has been rightly named 'the High Priest of the modern sun-worshippers' by another great worker in the domain of actinotherapy, namely, Dr. Gauvin. After visiting Leysin, Dr. C. W. Saleeby wrote, "No where on earth have I seen or heard of anything so beautiful, so significant, so hopeful, as the application of heliotherapy under the charge of Dr. Rollier."

Dr. Gauvin writes, "It is ingrained in healthy mortals to love light. Even those of sedentary habits who are unfitted for an outdoor existence prefer wel lighted and cheerful surroundings to darkness and gloom. A child before the age of reason instictively seeks the light and abhors darkness. Light and laughter synchronize -darkness and depression do likewise". The animals have the same instinctive love for light. It is a matter of common knowledge that unless the sun is very hot animals take rest rather in the sunshine than in the shade. "Mirth is banished when darkness envelops us, our sense become deadened and dulled and sleep supervenes". The preventive and curative value of sunlight was known from time immemorial. Dr Rollier himself says, "The practice of suncure is as old as the earth". In ancient India, sunlight was valued, and generally school classes were held in the open air under the shade of trees. Infants are still exposed to sunlight after besmearing them with oil. Sunlight has many uses in the treatment of disease and the sun is adored as a god in India, Greece, Babylon, and Egypt, and other nations also made use of the healing power of the sun.

The sun has been worshipped as the source of both life and light from very early times. Light has been looked upon as the giver of health and happiness, as the power that defeats the dreaded darkness closely associated with death and destructiou

It appears that the Aryans worshipped the sun, the great lord of all, and they named him Dyaus from which the Latin, *Deus*, and the English, *Deity*, seem to be derived. The Persians were sun-worshippers and the name of the Sun-god in Persia is Mithra, in Egypt Ra, in Greece Helios, and in Rome Sol. The famous temple at Heliopolis was the centre of sun-worship.

Hippocrates (460-370 B. C.), the father of medicine, Cornelius Celsus and Galen (130-200 A. D) practised heliotherapy by covering the head exposing the rest of the body to the sun. Cicero has described the solaria which the wealthy Roman citizens built at their country villas.

In Peru, the Incas have been considered as Gods, being the children of the sun. Syphilis was treated by them by light. In England, the Druids deified the sun and Stonehenge was the centre of sun-worship and Sabbath is still Sunday. Unfortunately, with the advent of Christianity all pagan practices, and worships were discredited and light treatment fell into disuse in Europe and there was no appreciable revival till the end of the last century. In Bolivia, the Chiriguanos Indians pray to the sun with the following words: "Thou art born and disappearest every day, only to revive always young. Cause that it may be so with me". Even at the present time, the Parsees worship fire, and Hindus regard light divine. Hence in two great religions, light-worship still plays an important part. In England the importance of sunlight was overlooked at the beginning of the industrial revolution with the first large use of coal for producing power. New towns sprang up and factories were quickly built and large amounts of coal were burnt wastefully with the generation of considerable amount of smoke, which cuts off light. It will be interesting to note that windows were taxed in England as late as 1851, when the taxes on windows were repealed and even now walled up windows could be seen in manufacturing centres in England. In this connection, the following suggestive lines of Sir Oliver Lodge will be of interest. "When the most efficient parts of sunlight are excluded, the organisms which flourish are of the lowest kind ; and the higher organisms are apt to succumb to their ravages when unaided by the beneficial influence of sunlight".

After Finsen, interest in light therapy was aroused again in 1902, when two outstanding men of medicine, Bernhard (in 1902) and Rollier (in 1903) of Switzerland, were drawn to the study and practical employment of heliotherapy.

Light therapy is the proved method of choice in some diseases and a most useful adjuvant in many

others. For prophylactic purposes, it has a wide scope that is receiving intensive study by the medical profession.

Apart from those diseases in which actinotherapy is specific without other treatments, it has "an extraordinary tonic effect, both mental and physical, so that it stimulates the patient's whole power over the minor foci of disease". It has been very well demonstrated that actinotherapy has exceedingly valuable uses in the treatment of rickets, metabolic disorders, nervous conditions, diseases of the respiratory tract, and it is now an established routine procedure in welfare clinics throughout Europe in ante- and post-natal cases and for backward infants. In hospitals, actinotherapy is of material assistance in strengthening patients before operations and in shortening convalescence.

In more specialized fields, actinotherapy gives excellent results in many diseases of particular organs: the skin, the eye, ear, nose, throat and genitourinary organs. Its value is proved in many forms of tuberculosis. In dental surgery local applications of actinotherapy or luminous heat are beneficial in treating sepsis and inflammation.

Actinotherapy has been practised with several kinds of artificial actinic light sources—*e. g.* Hanovia quartz mercury lamp made in various forms. It is a powerful source, efficient, economical, and easy to operate.

The Alpine Sun lamp of the Hanovia company is useful for ultraviolet light, 30% of the total energy output is in the ultraviolet. The Jesioneck Lamp is found useful in light clinic where group treatment can be adopted. The Kromayer lamp (water cooled) and Soullx lamps are designed for light treatment of small lesions or orificial conditions. For treating throat with actinic rays, Eidinow model lamp is suitable.

Ultraviolet light is used in general medicine, pediatrics, dermatology, dental surgery, gynaecology, ophthalmology, oto-laryngology, surgery and tuberculosis.

H. R. H. the Prince of Wales in his Presidential Address to the 1926 meeting of the British Association at Oxford summarized aptly the value of light in the treatment of disease and maintenance of good health in the following words:—

"Closely linked with the discovery of vitamins has been the more recent development of knowledge concerning the need of sunlight for health, in man and his fellow animals, as in plants. We know now that crippling deformities appear in the growing child, if he does not receive his proper share of the vitalizing rays of the sun, either directly or through the presence in the natural foods or vitamins which these rays have produced. Sunlight, or its artificial equivalents, has some importance already in the treatment of disease; but a realization of its significance for health has a much greater importance in preventive hygiene. There can surely be no plainer duty for a state charged with the health of an industrial civilization than to promote with all its resources the search for such knowledge as this, as well as to provide for its application when obtained."

The value of light in surgical practice, particularly in the operating theatre, is being realized and the results of pioneering work at the famous Necker Hospital of Paris are known all over the world.

When medical treatment alone has been disappointing in such diseases as lupus, *Alopecia areata*, hay fever, rickets, spasmophilia, tetany, parkinsonism, following Encephalitis *lethargica* and other diseases, light treatment is found to be efficacious.

Physicians have for ages empirically advocated convalescence in a sunny place, simply because it was observed that recuperation is rapid in sunshine. Dr. Rollier says, "Owing to the paucity of our knowledge concerning the action of light on the human body, the development of the technique of heliotherapy was of necessity chiefly empirical".

Results obtained in Diseases treated by Light

Dr. Rollier states that thousands of observations have proved that in the case of children, the organism most deteriorated by tuberculosis can be radically transformed by sun bath if carefully administered and combined with air bath. He reports, "In case of infantile surgical tuberculosis one sees regularly a complete uplift of general condition parallel with the progressive healing of

the infected centres, whether osteous, articular, glandular, peritoneal, or cutaneous. Solar action on these centres is by no means superficial. I have nearly forty thousand radiographic negatives showing conclusively that there is no tubercular lesion, however deep, which escapes the influence of solar rays. In numerous cases of infantile osteoarthritis showing advanced destruction, the power of radiation for the reconstruction and otseous recalcification may go so far as 'restitution and integrum'. The reconstruction of the skeleton is not confined to tuberculosis; it is frequent in all cases of rickets. Hess of New York and his collaborators, Pappen-heimer and Unger, have by experiments shown conclusively the increase of calcium and phosphorus in the blood under the influence of solar light".

Speaking of the preventible diseases. King Edward the Seventh used to say, "If preventible, why was it not prevented?" If light can cure diseases, it should be able to prevent diseases. It is now known that the judicial application of sunlight is one of the most powerful prophylactic agents. As the tuberculosis germ is contracted during infancy, it is desirable that efforts should be made to prevent its developments. To do this we should increase the child's own power of resistance. Dr. Rollier is of opinion that the best way of increasing the resistance of a child is to bring him in contact with sunshine and pure air. With this object in view Dr. Rollier started in 1910 a "preventorium" at Cergnat in the Ormonts Valley for carrying out preventive sunlight treatment primarily intended for children suffering from tracheo-bronchial adenopathy. After a few weeks, sickly children having narrow, hollow chests, weak limbs, and atrophied muscles are wonderfully changed. The skin is bronzed, the anaemic pallor is replaced by a rosy complexion and the general health is improved. The percentage of haemoglobin in blood increases, the muscles become firm, the breathing is deeper and X-ray examination reveals progressive healing of the tracheo-bronchial ganglions.

In the *Eighth Annual Report of the Scottish Board of Health* it is stated that the clinical results of the ultra-violet radiation have been quite numerous and important. The results achieved so far seem to justify the conclusion that light treatment is taking a very important place in medical science.

E. H. and W. K. Russel in their *Ultra-violet radiation and Actinotherapy* (1928) state, "The greatest field of usefulness for ultra-violet radiation lies in the prevention rather than in the cure of disease. It is, however, almost a specific remedy in such dissimilar conditions as rickets, surgical tuberculosis, *Alopecia areata*, spasmophilia, and hay fever; and in a very large number of diseases, it is a useful adjuvant, supplementing other necessary remedial measures". These authors have treated not only different types of tuberculosis by light but they have reported that beneficial results can be obtained with actinotherapy in the case of the following ailments: -Loss of hair, heart diseases, debility, diabetes, mellitus acidosis, gout, obesity, acute muscular rheumatism, lumbago, muscular tuberculosis, fibrositis, chronic rheumatism, rheumatoid arthritis, injuries to muscles, joints and ligaments, rickets, bone lesions, fractures, osteoporosis, osteomalacia, osteogenesis imperfecta, osteomyelitis, osteitis deformans (Paget's disease), tetany, amenorrhoea, anaemia (secondary and pernicious) chlorosis, leukaemia, purpura, haemophilia, affections of the endocrine glands, hypothyrodism, increased blood pressure, diseases of the heart, angina pectoris, Raynaud's disease, diseases of the central nervous system, mental diseases, neurasthenia, chorea, epilepsy, paralysis aggitans, encephalitis lethargica locomotor ataxia anterior poliomyelitis, neuritis, neuralgia sciatica, facial palsy, spasmodic torticollis, asthma, colds, bronchitis, pulmonary conditions due to the action of poisonous gases, empyema, emphysema, laryngismus stridulus, different types of pneumonia, pleuresy pleurodymia, whooping cough, dyspepsia, gastric ulcer, constipation, diaorrhoea, functional disorders of the gastrointestinal tract, abdominal adhesions, cirrhosis of liver, cholecystis, jaundice, haemoarhoids, fistula, marasmus, pyloric spasm, tetanus, latent malaria, nephritis, cystitis, architis, epididymitis, prostatitis, urathritis, gonorrhoea, dysmenrrhoea, sterility, treatment at the menopause, menorrhagia, metrorrhagia, post partum haemorrohage vulvitis, vaginitis, leucorrhea, pelvic peritonitis, pyelitis, infantilism, impotence, skin diseases, accompanied by anomalies of sensation, inflammatory lesions of the skin, inflammations of the surface epidermis, inflammation of the deep

epidermis, local infective inflamations of the corium, syphilis, new growths, ulcers, rodent ulcer, wounds, skin grafts, eczema and other skin troubles, diseases of the eyelids, diseases of the conjunctiva, diseases of the cornea, throat diseases, diphtheria, diseases of the nose, diseases of the ear, dental diseases, diseases of the periodontal membrance, acute and chronic nasal catarrh, lupus of the nasal mucosa etc.

Ultra-violet radiation is being used in the new monkey house and reptile house at the London Zoological Gardens.

E. H. and W. K. Russel write, "Captain Braithwaite, of the West African Medical Service, informs us that eczema, impetigo, furunculosis, lupus and psoriasis are unknown among the Nigerian negroes, and that extensive wounds heal rapidly without sepsis ; and, as already noted, Dr. Leuba, of the Swiss army, found that pigmented skins would not respond vaccination until the skin had actually been cut through, instead of merely being scarified as usual".

"Actinotherapy in the treatment of mental disorders is now in use in many hospitals."

"Actinotherapy is invaluable during pregnancy. The increasing demands of the growing foetus upset the calcium metabolism of the mother". Dr. Saleeby has emphasized the usefulness of light for night workers and workers in big industrial concerns who are deprived of their proper share of sunlight. In Baden, Germany, light baths for children are available in forty cities. The General Electric Company reported that in the winter their employees committed more mistakes and their output per hour was less than in summer months. The employee working under ultraviolet light produced more work than employees at the other end of the room.

Absorption of Radiations by the Skin

The short rays are absorbed by the thinnest layer of the epidermis and hence cannot penetrate deep into the body. According to Coblentz, the longer rays, 1000 A° to 14000 A°, have a greater penetration. On the other hand, rays of still greater wavelength, 10000 to 70000 A°, cannot penetrate deeply into the blood stream. The following quantitative measurements by Glitscher and Hasselbach are of importance in explaining the part played by light in the treatment of disease :—

Transmission by epidermis
percentage transformation by

Wavelength in A°	0·1 mm. thickness	1 mm. thickness
4360	59	0·5
4050	55	0·3
3660	49	0·08
3540	42	0·02
3130	30	—
3015	8	
2990	2	—
2970	0·01	—

The fundamental Action of Light in Heliotherapy

In a recent communication Coblentz states : "The action of these light rays on the blood stream is probably very complex. Part of the action is probably photochemical. But the supposition that the action of the light on one part of the body produces a fluorescence in the blood stream which is carried to or produces a fluorescence deep within an unilluminated part of the body seems untenable, because fluorescence is a phenomenon that occurs only at the point where, and only so long as, the object is irradiated, and it ceases the moment the light stimulus is shut of" Hence if a fluorescence which is introduced into the blood stream has a therapeutic effect, it is more likely owing to some photochemical change in the material rather than owing to the fluorescent property of the material. Some other nonfluorescent material might produce the same effect either by undergoing a photochemica change in combination with the material in the blood stream or by some catalytic action on the white blood corpuscles".

From their researches on the photo-oxidation of food materials by air in sunlight and the ordinary temperature, Dhar and Palit have concluded that the light absorbed by the system accelerates the metabolism of food materials in the body. The person thus has a sense of well-being, and disease is avoided. Sunlight is appreciably transmitted by the epidermis, and by absorption of light the body cells are activated, and hence increased oxidation of

carbohydrates, fats, and proteins takes place. It seems to be accepted on all hands that several diseases are caused by defective metabolism and therefore sunlight should prove efficacious in the treatment of these diseases.

It has been shown by Dhar and Sanyal that methyl alcohol, ethyl alcohol, and glycerol are oxidized by passing air at the ordinary temperature in the presence of sunlight.

Dhar and Palit have made a systematic investigation on the oxidation of the various substances by air in sunlight at the ordinary temperature. They have shown that different carbohydrates, glycogen, urea, glycine, hippuric acid, α-alanine, sodium urate, potassium palmitate, stearate, oleate, sodium formate, tartrate, oxalate, lecithin, cholesterol, butter, milk, egg-white, egg-yellowete, can be oxidized photochemically by passing air through the solutions or suspensions of the above materials exposed to sunlight. Some of the experimental results are recorded below :

Volume of air passed - 36.5 s in 5½ hours.

Substance used in the experiment	Percentage amount oxidized
Arabinose	
Galactose	
Cane sugar	10·2
Glucose	11·9
Laevulose	17·3
Lactose	19·7
Maltose	25·0
Starch	38·8
Glycogen	19·7
Glycerol	18·0
Urea	8·7
Glycine	9·6
α alanine	36·6
Hippuric acid	14·2
Sodium urate	19·6
Potassium stearate	40·0
Potassium oleate	31·5
" palmitate	36·7
Sodium formate	19·9
Potassium oxalate	15·2
Potassium tartrate	31·3

In presence of photosensitizers, the amounts of photo-oxidation of these substances are greatly increased.

Dhar and Palit have also carried out comparative experiments on the oxidation of egg-white, egg-yolk, starch, butter, glucose, cane sugar, and glycogen in sunlight by passing air, and the following are the results :—

Volume of air passed 60 litres in 9 h

Egg yolk	60·8 percent
Egg-white	31·25 "
Starch	38·2 "
Butter	31·8 "
Glucose	13·6 "
Cane sugar	7·8 "
Glycogen	7·5 "

It appears therefore that egg-yolk is the most easily oxidizable substance in presence of light; then comes butter which is oxidized with greater ease than sugars which are the least oxidized. These experiments are close imitations of the biological oxidations; and a similar order regarding the ease of oxidation in the animal body was observed by Carl von Voit, the great German physiologist. These results on the oxidation of food materials by air in sunlight are suggestive, and the beneficial influence of light in the treatment of disease may be due to an increased metabolism in light.

The writer of this article has emphasized that the deficiency diseases like beri beri, pellagra, sprue, rickets etc., begin with stomachic troubles. Moreover, with pernicious anaemia, cancer etc., the same symptoms are also observed. Diabetes is associated with defective metabolism of glucose, which mainly passes out unchanged without oxidation from the body of the person suffering from diabetes. Gout is supposed to be caused by defective metabolism of proteins. The researches of Dhar and Palit have shown that carbohydrates, fats, and proteins are readily oxidized by air in presence of sunlight. The light absorbed by the animal body accelerates the oxidation of carbohydrates, fats, and proteins, and hence diseases like beri-beri, pellagra, sprue, rickets, cancer, pernicious anaemia, diabetes, gout, osteomalacia, measles etc., which originate with defective metabolism of food materials, should be prevented or cured by light treatment. The present writer has emphasized the importance of sunlight in the treatment and prevention of deficiency and metabolism diseases, and it seems likely that rickets,

osteomalacia, beri-beri, pellagra, sprue, diabetes, gout, pernicious anaemia, cancer, measles, etc. would have been more prevalent in poor tropical countries like India and China where the food material lacks in vitamins and good quality proteins and is also defective from other view points, had not the compensating agent, sunlight, been present. Medical men are definitely of the opinion that cancer, the deadful enemy of humanity, is less frequent in India than in Europe. Rickets is much rarer in India than in England. This is chiefly due to the fact that we get more sunshine than available in most European countries.

The present writer has emphasized that rickets is associated with the defective metabolism of fatty food materials. When the foodstuff lacks in vitamins A and D which occur in butter, milk, codliver oil, but not in vegetable oils, the fat is not completely oxidized to carbonic acid and water, which are formed when the food materials undergo proper and complete oxidation ; the products of incomplete oxidation of foodstuffs are organic acids. It is well known that in rickets acidity which is due to the incomplete oxidation of food materials is always observed. In presence of acids, calcium carbonate and phosphate, which are the main ingredients of bone, cannot be deposited satisfactorily due to the solvent action of acids on calcium carbonate and phosphate. The proper treatment of rickets is to remove the acidity by improving and making the oxidation of fats in the animal body complete. This can be accomplished by vitamins A and D, alkalies, and light, and all these agents accelerate the oxidation of fats.

From the researches of Dhar and Palit, it will be evident that fats are more readily oxidized by passing air in presence of light than the sugars and nitrogenous compounds. It appears, therefore, that in the animal body the light absorbed will also accelerate the oxidation of fatty food materials to a greater extent than the proteins and carbo-hydrates, and consequently, light is more effective in th prevention and cure of rickets than that of gout and diabetes. As a matter of fact, light acts as a specific in the treatment of rickets and explained from the researches of Dhar and Palit on the photo-oxidation of food materials.

It appears therefore that light in the prevention and treatment of diseases not only acts as a stimulant of the body cells but also as an accelerator of the metabolism of the food materials in the body. As a matter of fact, Sir Leonard Hill has observed an increase in the metabolism by 10% where children are exposed to sunlight.

Book Review

Economics of Engineering *—By B. C. Chatterjee and L. D. Coneslant. Published by Surjya Narayana Chatterjee, Benares, 1934, pp. 618, price Rs. 12.*

This book is based on the lectures in Engineering Economics, delivered yearly to the graduate class in Engineering of the Benares Hindu University. It is chiefly concerned with the economics of mechanical and electrical engineering but it includes many other things which are of use to a practising engineer. There is, for example, a chapter on Law, dealing primarily with those enactments which directly or indirectly touch the practising engineers. The aim of the book, according to the authors, is "to make the instruction given to engineering students more practical in the business sense than has hitherto been customary in engineering colleges." To attain the end the authors have devoted a fair part of the book to such purely economic topics as Money, Capital, Trade, Transport, Banking, and Insurance, while commercial topics like the maintenance of the ledger, and other auxiliary books, organization of industry and its management, the calculation of depreciation, and so forth occupy a good space.

After going through the book with the care that it deserves, I feel no hesitation in saying that the authors have succeeded with credit in producing a work which has attained the desired result to a considerable extent.

Evidently, the authors do not claim to be experts either in economics or in the commercial topics they have discussed in the book. And that is exactly what one would expect of persons who are primarily concerned with engineering problems. This accounts for a number of statements, specially in chapters dealing with Money and Banking, which to a student of economics would not appear to be strictly correct. Thus we are told that the price of a thing depends on three things, *viz.* (1) money in circulation, (2) effective demand, and (3) the supply. This is quite true, but when the authors add that the prices of thing do not depend on (1) their utility, and (2) the amount of labour and skill expended on their making, they contradict themselves, as numbers (2) and (3) of the above are nothing else but numbers (1) and (2) of the latter statement. This is only one instance of the many theoretical inconsistencies that one comes across in this otherwise very interesting and instructive work. A revision by an expert economist of the portion dealing with purely economic topics will greatly enhance the theoretical accuracy of this work.

B. G. Bhatnagar.

Atomic Physics—*By Prof. Max Born. Authorized Translation from original German by John Dougall. Published by Blackie and Son Ltd., London and Glasgow, 1935, pp. XII + 352, price 17s. 6d.*

Vast and revolutionary changes in our concepts of space and time, matter and energy have taken place during the present century. The revolt against the classical idea of the continuous variation of the energy of light was led by Prof. Planck who postulated the existence of discrete and finite quanta of radiant energy $\epsilon_0 = h\nu$ to obtain the correct law of the distribution of energy in the spectrum emitted by a black body radiator. Although this revolutionary hypothesis met at first with the most violent opposition and was regarded only as a mathematical artifice to get the result, the assumption has been amply justified by its success in explaining other atomic phenomena. A further development of the quantum hypothesis has been the extension in recent years of the dual idea of waves and corpuscles also to matter by De Broglie. Prof. Max Born has taken all along an active part in these developments and a book by him on the subject is warmly welcome.

The atomic nature of matter has been first introduced by a discussion of the kinetic theory of matter in the first chapter. The natural sequence of this has been to describe in the next chapter the production and properties of the elementary particles. In the third chapter experimental evidences of the nuclear

disintegration and artificial radioactivity have been described.

The dualism in the properties of matter and radiation forms the subject matter of the fourth chapter, while in the following one Bohr's theory af the atom and its refinement in matrix and wave mechanics has been discussed. Spin af the electron and Pauli's exclusion principle and their application to atomic phenomena and the periodic classification have been taken up in the next chapter. The last two chapters deal with quantum statistics and molecular structure.

The main body of the book has been wisely kept free from all complicated mathematical analysis which has been put at the end of the book in farm of appendices which number no less that thirty one and cover about hundred pages. The reader is thus better able to follow the physical ideas and is not caught in the whirlpool of difficult mathematics.

No attempt has been made to follow the historical order of development. A necessary consequence of this mode of treatment has been the anticipation of results in many instances. For example in chapter II neutrons and nuclear consituents have been discussed although the idea that the atoms have a central nucleus has been developed in chapter III from the scattering experiments.

Although all the latest develapments, including the new field theory by Born and Irfeld, have been mentioned many important subjects have been given only a passing reference. The whole subject, for example, of the electrons in the metals has been inadequately treated. Only workers in the field have been ennmerated and even Sommerfeld's application of the Fermi Dirac Statistics to electron theory of metals has been but just touched. One would have very much appreciated the detailed treatment of these subjects in the hands of Prof. Born.

This sketchy treatment of the subject has resulted in same misleading statements in certain places. For example, referring to the diagram on page 148 showing the various terms in the alkaline and X-ray spectra, it has been said on page 149 that the energy difference between the levels with different total quantum number n is 10^3 to 10^4 times that in the same sublevel. While the statement is true with respect to hydrogen and X-ray spectra, it does not hold in the case of the alkali atoms where energy differences are of the same order as the term-values themselves.

The book thus will not prove very useful to the beginner although those wha know the subject may read the book with advantage as it will present to them new view points.

R. N. Rai.

Candle Manufacture—*By Professor Dr. N. N. Godbole, assisted by R. N. Mehta, Benares, 1935 iv + 29, price Rs. 2.*

Inspite of the advent of electric light, candles are being extensively used in festivities in rural areas, in churches, and for decorative purposes in Burma and Bhudhistic countries. The only concern which manufactures candles in the Indian Empire is the Burma Oil Company. It is therefare a happy augury to see that we are being interested in this industry which in practice is a monopoly of a single company. Although the manufacture of candles is very simple and requires a small capital yet a preliminary training in the technique as outlined so ably in the book *Candle manufacture* by Prof. N.N. Godbole of the Benares Hindu University is essential. The blending af Paraffin and stearic acid in arder to attain desired melting point, the manufacture of stearic acid and impregnation of wick by various chemicals to produce various effects—all have been carefully written. As a text book for candle manufacture—the book may be safely recommended.

M. Goswami.

A comparative study of the utility of the milks and ghees of the Indian cow and buffalo as human food materials—*By Prof. Dr. N. N. Godbole and Sadgopal, M. Sc.*

This is a useful pamphlet giving comparative analyses of milk obtained from different species including the human. Ghee prepared from the milk of the cow and the buffalo has been compared with mutton tallow, beef tallow, lard and cocoanut oil. The nutritional superiority of ghee is indicated. Cow's butter fat is stated to be more assimilable than buffalo-butter fat.

The Problem of Nutrition

B. C. Guha

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The problem of feeding the nations has attracted widespread attention throughout the civilized world, more especially during the post-War period. The role of proteins, carbohydrates, fats, and salts in human nutrition has long been recognized as a result of the researches of Liebig, Voit, Rubner, and their schools. But the realization that small amounts of substances of undefined nature occurring in natural foodstuffs are also essential for life and health came only during the first decade of the present century. The difference between protein and protein in the ability for the building and repair of tissues depending on their amino-acid make-up also came to be recognized at a comparatively recent date. The new ideas were harnessed in planning the emergency rations of armies as well as of civil populations during the last war. But more intensive investigation of national dietaries during the last decade and a half has revealed strikingly that even during peace time the diet consumed by large populations even in comparatively wealthy countries is not calculated to afford optimum nutrition. It is, of course, still the contention of some complacent people that instinct is the best guide of proper nutrition. There is, however, ample evidence at present to show that this contention, however pleasing, is by no means true, and that the present standard of health of specially the working population in practically all countries is certainly not the optimum that could be reached by rational feeding. Sir John B. Orr, who is the director of the Rowett Research Institute, Aberdeen, and is a well-known authority on nutrition, drew pointed attention at the last meeting of the British Association to the deplorable state of affairs in the United Kingdom. From his own studies of a great many family dietaries he has come to the conclusion that all families which have an income of less than £ 1 a week per head are under-nourished. The vast masses of the working class would thus appear to be habitually on a deficient diet, which would undoubtedly undermine their efficiency and affect their powers of resistance. The question of undernutrition in England has recently received much attention from the British Medical Association and the Royal Society. Sir John Orr's exhortation for a national food-policy appears to have obtained some official support in Great Britain and the Marquess of Linlithgow, who has been associated with problems of agriculture both in India and in England, recently spoke strongly in favour of it. The problems of agriculture and of the nutritional needs of man are, indeed, intimately connected, and the harmony between them requires the substitution of *laisse: faire* by planned production from both the standpoints of agricultural economics and of dietetics. Last September, in the League of Nations Assembly, Mr. Stanley Bruce and Lord de la Warr, the Australian and British delegates respectively, referred to the paradox of surplus food and the under-fed man, and suggested that the question of proper nutrition should be as much a concern of Governments as sanitation and public health already are. The scientific knowledge of nutrition that has been garnered is not yet being utilized by the ordinary man in India or elsewhere partly from ignorance and more specially from poverty. Whether all is well with a social organization which permits wealth to lie side by side with misery and allows wheat to be burnt while millions go hungry, it is not the purpose of the present article to enter into. We shall deal here only with some scientific and organizational aspects of the nutritional problem.

The organization of nutritional studies and their application to the question of raising the nutritional level of the community have received some special attention in U. S. S. R., Japan, Great Britain, France, and America. There are institutes and laboratories

for nutritional research in all these countries, and this is carried out both in the purely scientific aspect and in relation to social classes, occupations, institutions, and so on. The prolonged investigation of Corry Mann on the nutritive value of milk, to which Sir F. Gowland Hopkins referred in an address before the Royal Society of Arts, has stimulated milk-consumption in Great Britain and it has been stated that the British Government supplied free milk to many thousands of children and mothers during the last year. In U. S. S. R. the Soviet Government have, according to their usual methods, instituted thorough-going enquiries into practically all aspects of nutrition and have taken steps to see that needs, and not income, must determine nutrition. In U. S. S. R. there is a State Institute of Nutrition at Moscow, besides another at Odessa, and a Vitamin Institute at Leningrad. In Japan milk consumption has also made much head-way, specially among school children under organized guidance and with very substantial State subsidy.

The Problem of Nutrition in India

In this country, McCarrison has done some pioneering work on nutrition. Goitre, stone, and night blindness have been associated with faulty nutrition. Beri-beri has long been known to be connected with vitamin deficiency. It is probable that many other disorders may have some relation to nutritional deficiency, though it may be to a limited extent. What is, however, more important to realize is that even when the dietary deficiency is not so great as to cause typical diseases, chronic subnutrition can produce a standard of health which is much below optimum. On such a low level of nutrition, efficiency and the capacity for resisting infections are inevitably undermined.

From even a qualitative study of the dietetic habits of the people of this country, it is clear that the bulk of the masses are living on a very one-sided carbohydrate-rich diet. McCarrison has shown that the average Punjab diet is vastly superior to the average Bengal or Madras diet. Whole wheat is a more nutritive cereal than milled rice from the standpoints of protein, vitamin, as well as mineral values. We have found how low a diet consumed in a "mess" in Calcutta is in both vitamins A and B.

Unfortunately, however, nutritional research in India is still in its infancy. Large numbers of foodstuffs have not yet been investigated with reference to protein, vitamin, and mineral values. The usefulness of such research is indicated by the fact that some common fruits like the mango, guava, and pineapple have been found to be richer in vitamin C than the Indian lemon and orange, the well-known antiscorbutics. The liver oils of several kinds of fish in Bengal have been found to be considerably richer than cod-liver oil in vitamin A. Investigation of the protein and mineral values of some vegetables has shown that the common vegetable, *palta* (leaves of *Trichosanthes dioica*), is a particularly important foodstuff, being fairly rich in calcium, phosphorus, iron, and protein. What is, however, needed is a systematic survey of the nutritive values of Indian foodstuffs and this has been undertaken at the Indian Institute for Medical Research. The chemical and biological study of actual dietaries as they are consumed in families and institutions is also highly important, because it is by relating this information to the researches on individual foodstuffs that model dietaries can be constructed. It is obvious that the problem of nutrition is intimately connected with agriculture and medicine (especially preventive), and these implications should receive the requisite attention.

Some Suggestions

It is essential that the nutritional researches that are being carried on at different centres in India should be co-ordinated. The climates, soils, and dietary traditions vary from place to place. Different kinds of foodstuffs are available at different places. Different occupations require, as is well known, different nutritional standards. In order that all nutritional researches in this country might flow in one big stream for the promotion of a higher standard of health of the people, it seems desirable that a Central Nutrition Board should be formed, as I have suggested several times during the last two years. It would not be out of place if the Indian Science Congress takes initiative in this direction, presenting as it does an All-India scientific forum.

This Board or Committee should try for the establishment of a Central Institute of Nutrition (as has also been recommended by the Agriculture and

Labour Commissions), which should carry on researches in purely scientific as well as in all applied aspects, and should form an authoritative body for controlling and directing the dietary habits in this country both for individuals and for institutions. The Institute should work in close co-operation with organizations representing agriculture and medicine. The problem of the nutrition of children, adolescents, pregnant and nursing women, and of working class populations should receive special attention. It is only when sufficient data have been culled that we shall be able to feed our nation intelligently, so far as the appalling poverty of the Indian people would allow.

Alipore Observatory
Seismic Statement for October, 1935

Date	Time of beginning I. S. T H.	M.	S.	Intensity	Epicentral distances (miles)	Remarks
1. 10. 35	11	44	54	Slight	980	
2. 10. 35	11	12	5	„	3,490	
4. 10. 35	10	52	25	Tremor	—	
„	20	25	33	Slight	1,470	
6. 10. 35	12	57	21	Tremor		
„	20	18	14	Slight	1 130	
8. 10. 35	14	54	10	Moderate	1,510	Epicentral region possibly near the Hindukush Mountains.
11. 10. 35	1	45	21	Tremor	—	
„	9	55	28	Slight	1,060	Reported to have been felt at Peshawar.
12. 10. 35	3	56	8	„	4,000	
„	22	24	16	Moderate	3,710	Epicentral region possibly in the vicinity of the Kurile Islands (Nth. Japan)
13. 10. 35	7	36	19	Slight	3,460	
15. 10. 35	1	59	7	„	1,180	
17. 10. 35	20	7	28	„	1,460	
18. 10. 35	5	50	50	Moderate	3,450	Epicentral region possibly in the neighbourhood of Sakhalin Islands to the north of Japan.
„	16	44	33	„	3 470	
„	20	32	48	Slight	3 480	
19. 10. 35	3	30	20	„	3,510	
„	6	52	47	Tremor	–	
„	8	22	41	„	—	
20. 10. 35	1	55	20	Slight	250	Reported to have been felt at Shillong and Jorhat.
„	10	27	22	„	1,910	
26. 10. 35	14	11	7	„	360	
27. 10. 35	2	55	48	„	1,060	
„	12	25	42	Tremor	—	
28. 10. 35	17	45	18	Slight	1,030	
30. 10. 35	8	4	46	„	520	

The Nobel Prize Awards in Physics and Chemistry, 1935

N. K. Saha

PHYSICS: Dr. James Chadwick.

Dr. J. Chadwick to whom the Nobel Prize in Physics for 1935 has been awarded has been a pupil and coworker of Lord Rutherford, and was until recently assistant director of Radioactive Research in the Cavendish Laboratory, Cambridge. He has been throughout his career associated with Lord Rutherford in his investigations on the nuclei of atoms. In 1911, Rutherford had shown definitely from large angle scattering of α-rays that the whole positive charge and the mass of the atom is concentrated within a minute region or *nucleus* in the centre of the atom. The dimension of the nucleus was shown to be a hundred thousand times less than that of the atom. The nuclear theory of the atom was the basis on which Bohr in 1913 built up his wonderful theory of the atomic spectra.

While the other workers were utilizing the nuclear theory on other directions, Lord Rutherford and his pupils were concentrating their energies on the structure of the nucleus itself. In 1920, Chadwick showed that by an accurate determination of large angle scattering it is possible to estimate accurately the charge on the nucleus. In 1925, Rutherford and Chadwick showed that by bombarding the light elements with high speed α-rays we can find out whether the inverse square law held right up to the nucleus. They found considerable deviations from it at close quarters to the nucleus, and discovered that apparently near the nucleus the repulsion changes to attraction, creating what is known as the *Potential Barrier*. But for this barrier, the nucleus would automatically explode as it is composed of particles which mutually repel each other. In 1921, Rutherford bombarded the nucleus of nitrogen atom by high speed α-particles from ThC, and showed that the nucleus was disrupted and proton was emitted. This discovery opened the way to the wonderful series of experiments in the modern nuclear physics on the artificial transformation of elements.

The circumstances which led to the discovery of the neutron for which a Nobel Prize has been awarded to Dr. Chadwick are quite simple. Bothe and Geiger in Germany allowed the element beryllium to be bombarded by high speed α-rays from Po and found that Be gave highly penetrating radiation. The nature of this radiation was investigated by Bothe and Becker and by Curie and Joliot in Paris but it was left to Chadwick to give the correct interpretation of these radiations. Withdrawing the source of Po Chadwick and his coworkers placed a block of paraffin in front of the Be-sample. An examination by means of Geiger-Müller counter showed that high speed protons, or hydrogen nuclei, have been emitted by the paraffin block. Further, considerations of the range and ionization of particles produced by the protons showed that their origin must be due to their impact with very fast particles of mass nearly equal to that of the proton. From a detailed study of the energy and the extremely high penetrating power of the new particles, they were identified by Chadwick with particles of mass 1 and charge 0 and were called neutrons. A more detailed account has been given by professor Saha in SCIENCE AND CULTURE of June, 1935.

The properties of the neutron are now being vigorously investigated all over the world. It has been found that though it has no charge, it possesses a magnetic moment which is of the same order of magnitude as that of the proton, *viz.* $eh/4\pi Mc$. It is not yet quite clear how this moment arises. The neutron may be a doublet composed of two magnetic particles of opposite signs, as suggested by Kothari. Recently Chadwick and Goldhaber have shown that

the neutron is heavier than the proton. This discovery perhaps negatives the earlier idea that the proton is a neutron plus a *positron*. It appears more likely that a neutron is a proton plus an electron.

The discovery of the neutron has thus created quite a new situation regarding the origin of electrical charge, mass, origin of magnetism, and the question of fundamental particles in nuclear constitution. There can be no doubt that future years will see more exciting discoveries in this line.

CHEMISTRY: Prof. F. Joliot, and Madam Irene Curie-Joliot.

Madame Irene Curie-Joliot who, with her husband, Prof. E. Joliot, has been awarded the Nobel Prize in Chemistry is the daughter of the celebrated scientific couple, Prof. P. Curie and Madame Curie, the joint discoverers of Radium. So it appears that in this case family history has repeated itself.

The award has been made for their discovery of "Induced Radioactivity." The discovery of Radioactivity itself was made by J. Becquerel in 1896, but the proper understanding of the phenomenon was arrived at by the successive researches of Prof. and M. Curie, Rutherford and Soddy, and other workers. But up to 1925, it was found that the phenomenon was confined only to heavy elements (uranium to lead), though some light elements like potassium and rubidium were also known to possess slight radioactivity. For a long time, the French school of investigators, inspite of the great initial work of the Curies, made no first class contribution to the subject of radioactivity and the Joliots themselves narrowly missed the discovery of the *neutron*, for they were under the impression that the neutrons were hard gamma rays.

This failure was however amply compensated by their discovery of 'Induced Radioactivity' in 1934. In April of this year the Joliots were bombarding boron, magnesium and aluminium with α-particles, thus trying to repeat Rutherford's earlier attempts at nucleus breaking. They were obtaining protons, neutrons, positrons, and γ-rays, The idea occurred to them, however, to test whether even after the removal of the bombarding α-particles any activity could be traced in the atoms which were subjected to the α-ray bombardment. They found that the atoms were still active, and the activity was traced to the emission of *positrons* by the nuclei. The activity was found to decay according to the law of monomolecular reactions just as in the case of ordinary radioactive bodies, and the half value period was found to be 14 minutes for B, 2.5 minutes for Mg, 3.25 minutes for Al. The process may be described as follows :--

$$B_5^{10} + He_2^4 \longrightarrow N_7^{13} + n_0^1$$

$$N_7^{13} \longrightarrow C_6^{13} + e^+$$

i. e. when the α-particle enters the nucleus of B_5^{10} it shoots out a neutron, and N_7^{13} is formed. But N_7^{13} is unstable, as its mass 13 is less than 2×7 so it tries to revert to a stable state. It can do so only by the emission of a positron e^+ and C_6^{13} so formed is stable.

The work of Curie and Joliot has been elegantly extended by Fermi and his pupils in Italy. In the original experiments of Curie-Joliot, α-particles from ThC were used for bombarding the nuclei. But on account of the existence of a potential barrier in the nucleus, there is a sharp limit to the closest approach of the particles to the centre of the nucleus. To obtain still closer collisions, Fermi employed neutrons as the bombarding particles. The neutron having practically no electrical charge at all cannot be stopped by the potential barrier, and can thus penetrate deep into the nucleus. In this way Fermi and his collaborators have made a systematic study of induced radioactivity from all the elements in the periodic table and their different isotopes.

The process of induced radioactivity leads to the formation of many nuclei not ordinarily known. In fact, Curie and Joliot have been able to separate a whole group of radioactive elements of the series $4n+1$ formed by this process. This adds a new group to the three series of radioactive elements $4n$ (Thorium family), $4n+2$ (Uranium Radium family) and $4n+3$ (Actinium family) already known.

The nuclear interactions of induced radioactivity have led to a new estimation of the neutron, and thus throw light on a highly controversial question. The phenomenon of induced radioactivity has thus led to many interesting consequences, and is believed to be a potential source of future informations regarding the structure of nuclei.

Alkali soils and their Reclamation

N. R. Dhar

Professor of Chemistry, Allahabad University.

Baron Berthollet, one of the greatest luminaries of French Science, who accompanied Napolean in his Egyptian expedition towards the end of the 18th century was struck by the fact that solid sodium carbonate existed on the banks of the Nile. Being one of the founders of the law of mass action Berthollet believed that the sodium carbonate was formed by the interaction of sodium chloride obtained by the flooding of the Nile and the calcium carbonate present in the soil. This hypothesis was supported by Hilgard and his colleagues in California, who are pioneers in the reclamation of alkali soils in the United States, and by the workers in the United States Bureau of Soils.

An ingenious explanation of the formation of sodium carbonate was offered by Paul de Mondesir in 1888. He was impressed by the fact that calcium chloride is obtainable in the acqueous extract of a soil situated near the sea. And he believed that it must have been found by the action of sodium chloride on the soil. He tried to explain what happened to the sodium which did not exist in the soluble state. In order to test this point, he treated soil with a solution of sodium chloride in the laboratory and could obtain calcium chloride and an insoluble sodium compound. When calcium cloride is removed by washing, the insoluble sodium compound is easily decomposed by the action of carbonic acid forming sodium carbonate. By the successive interaction of sodium chloride, water, carbonic acid, and water again, he was able to obtain 100 gms. of sodium carbonate from 1 kg of soil. His experiments prove, therefore, that the sodium chloride does not react with calcium carbonate as was assumed by Berthollet, but it reacts with the soil forming a sodium adsorption complex and calcium chloride which can be removed by washing. The sodium adsorption complex can be decomposed by carbonic acid with the formation of sodium carbonate. The explanation of Paul de Mondesir has been developed and supported by the well-known Russian exponent of soil science, Dr. Gedroiz and is generally accepted.

Principles of Colloid Chemistry were utilized by Gedroiz in his investigations on alkali soils of Russia and their reclamation. Gedroiz observed that the amount of sodium carbonate that could be dissolved by adding water decreased with successive addition of water. He concluded that the sodium carbonate existed in the adsorbed state in the soil. When the soil was treated with sodium sulphate or chloride the amount of sodium carbonate extracted with water increased. When sodium chloride and calcium carbonate were added to soil and extracted with water, small amounts of sodium carbonate were obtained. From his experiments Gedroiz concluded that the formation of sodium carbonate in the alkali soil proceeds in three stages—the first is the reaction between the sodium chloride and the soil, the second is the washing away of the soluble product, and the third is the reaction between the insoluble sodium compound and the carbonate. The simplest explanation is to assume that the sodium chloride reacted with the zeolitic silicates forming a sodium clay which reacts with the carbonate to form sodium carbonate and a calcium clay. This explanation of the formation of the alkaline soils leads us to a method of reclaiming them. Washing away of the carbonate with water is certainly inadequate as long as the clay remains a sodium one. The proper step should be the replacement of sodium by calcium and this was effected by Hilgard and his associates in California for the reclamation of alkali soils in the Western States of the United States. The alkali soil was treated with gypsum (calcium sulphate) and followed by flooding with water ; 12 tons of gypsum per acre of soil was used and this led to the formation of sodium sulphate which could be washed away and the sodium clay was converted into the calcium one. The gypsum treatment was

also adopted in reclaiming large tracts of land in Russia according to the suggestion of Gedroiz and his colleagues.

Powdered sulphur at the rate of 20-30 cwt. per acre has been used with beneficial results for the reclamation of alkaline soils. By the joint action of bacteria and light the sulphur is oxidized in the soil forming sulphuric acid, which neutralizes the alkali present in the alkali soils. Ammonium sulphate has also been used, and this reacts with calcium carbonate forming calcium sulphate, which can be washed out by flooding.

The reclamation of Hungarian alkali soils has been carried on by de' Sigmond. The soils containing sodium salts are reclaimed by reducing the evaporation from the surface and by growing lucerne which requires large amounts of moisture and dries up the soil. In this way, the upward movement of the salt is decreased. Press lime, gypsum, farmyard manure, etc. have also been used in dissolving the calcium carbonate.

Interesting results have been obtained in the reclamation of the soil spoilt by sea water by Dymond and his colleagues in England. They observed that flooding of land by sea water at first kills the vegetation by the direct action of the salt. When the flood subsided and the rain started, the soils were washed resulting in a partial removal of the salts deposited from the sea water. At this stage, the soil was well suited for a good crop yield. But when the soil was further washed by rain, it deteriorated, as the small amounts of salts necessary for the flocculation of the clay particles were removed and the clayey soil did not subside for weeks, and hence cultivation was difficult. Dymond showed that calcium and magnesium of the soil were displaced by sodium from the salt water. The initial favourable effect was due to the coagulating action of the residual salt, left on the clay. But when the salts were further washed away by rain, the lack of the presence of electrolytes caused the soil to be muddy, and flocculation of the clay particles difficult.

Dutch investigators, notably Hissink and his collaborators, from their experience in the Zuyder Zee reclamation scheme, are in agreement with the observations of Dymond and his colleagues. Hissink has stated that the soil left after the sea water has drained away is infertile, because it contains sodium clay, and in order to make it fertile it must be converted into a calcium clay. The Dutch soil contains enough calcium for the conversion of the sodium into a calcium clay, but the operation takes time.

The Dutch investigators have found that the soil in the Zuyder Zee area contains sufficient amount of calcium salts for the conversion of the sodium clay into the calcium one. In the first year after the drainage of the sea water, the soil is sticky, wet, and infertile, and unsuitable for vegetation. In the second year, the rain water removes a good deal of the salt and the soil dries up appreciably and is suitable for plant growth. But this state of affairs does not last long, and in the third year, practically all the salt is washed out again making the soil sticky and unsatisfactory for cultivation. In the fourth year, the calcium compounds react with the sodium soil converting it into a calcium one; thus the soil Is made suitable for plant growth and at this stage the Dutch farmers begin their cultivation.

It wil be evident from the aforesaid that much work has been done in the reclamation of alkali soils in the United States, Russia, Hungary, England, France, and Holland. No systematic work has been carried out in this country in reclaiming large tracts of alkali soils in Northern India as well as in the sea-water-damaged lands is Sundar Bans in Bengal and in the Bombay Presidency.

A systematic investigation is in progress in the Allahabad University Chemical Laboratory for the reclamation of alkali soils of the dry tracts of Northern India by the application of molasses. It is well known that molasses contains between 60 to 65 per cent of carbohydrates, 4.5% potash, 2% lime, 0.5% phosphoric acid, 0.5% silica, 0.5% iron and aluminium oxides, 0.5 % combined nitrogen, and the rest water. Moreover molasses is distinctly acidic. Research work carried on in Allahabad, Bangalore, Java, Hawai, and other sugar producing countries, shows that when molasses is added to the soil along with carbonic acid, organic acids like acitic, propionic, butyric, lactic, etc. are produced in the early stages in the decomposition and partial oxidation of the carbohydrates present

in molasses. Consequently, the acids present in molasses and those obtained from the decompositions and partial oxidation can neutralize the alkali of the soils, rich in alkali. Moreover, the carbonic acid which is produced in large amounts from the decomposition and oxidation of the carbohydrates can convert the sodium carbonate into bicarbonate. Also in the process of the escape of carbonic acid from the soil, the latter is rendered porous and its tilth is improved. The investigations at Allahabad show definitely that the moisture content of the molassed soil is appreciably higher than that of the unmolassed one. The lime which is added to the soil along with the molasses is helpful in the conversion of the sodium soil into the calcium one.

In publications on the utilization of molasses as a fertilizer, we from Allahabad have shown that ammonium salts and total nitrogen are increased when molasses are added to the soil which has to be aerated by ploughing. It has been established that the energy set free in the oxidation of the carbohydrates of the molassees is utilized in the fixation of the atmospheric nitrogen in the soil. The oxidation of the carbohydrates in the molasses leading to nitrogen fixation can be effected through the agency of bacteria (azotobacter) sunlight, inductors and catalysts like iron, copper, manganese, and titanium compounds. All these substances are present in the soil under normal conditions. Hence along with the neutralization of the sodium carbonate of the alkali soils by the acids produced in the decomposition and partial oxidation of the carbohydrates of the molasses, appreciable amounts of ammonium salts and proteins are added to the soil which is thus rendered fertile. The acetate, propionate, butyrate, lactate etc. produced in the neutralization of the organic acids obtained from molasses and sodium carbonate of the alkaline soils are also oxidized in the soil in course of time, liberating further energy to be utilized in the fixation of atmospheric nitrogen.

It is well known that when energy-rich substances like carbohydrates, proteins, etc. are added to the soil its microbial population is greatly increased, as the micro-organisms can utilize the energy-rich compounds as food for their growth and multiplication. The micro-organisms are helpful in the docomposition of the soil organic compounds, and in the conservation of the nitrogen, and thus the porosity and fertility of the soil is increased, The workers at Allahabad and at Java have shown that the fertilizing action of molasses when added to ordinary soils is not due almost exclusively to the carbohydrates existing in the molasses, as it has been established that the effect produced by equivalent amounts of nitrogenous compounds, potash, and phosphate on the growth of vegetation is exceedingly small in comparison with the effect produced with molasses.

Molasses to the extent of 90-270 maunds per acre has been applied to some alkaline fields in Cawnpore and other places in the United Provinces in two consecutive years, and three months after the second application an excellent crop of sun-hemp was obtained where no vegetation could be grown due to the high alkalinity of the soil. If a larger quantity of molasses were used, say 300-500 maunds per acre on the alkali soil, plants would be grown in them six months after the application of the molasses. It is clear therefore that over and above the well-known methods available for the reclamation of alkali soils (e. g. addition of powdered sulphur, gypsum, ammonium sulphate etc.) molasses can be utilized in the reclamation of alkali soils. This method should be useful especially in areas near sugar factories. Molasses when added to the soil neutralizes the sodium carbonate of the alkali soils, increases the soil micro-organisms, the nitrogen and ammonia contents, and also the water retention capacity. Moreover, it improves the soil tilth and humus content. The calcium added with molasses also helps in the conversion of the sodium clay into the calcium one, and all these go to the reclamation of the alkali soils.

Sir U. N. Brahmachari

We give below a brief sketch of the life and work of Sir Upendra Nath Brahmachari, who has been elected the General President of the next session of the Indian Science Congress to be held at Indore in January 1936. We have no doubt that it will be of great interest to the public in general and the scientists in particular.—EDITOR, SCIENCE AND CULTURE.

Sir Upendranath Brahmachari was born on the 7th June, 1875, in Jamalpur, E. I. Ry. (Dt. Monghyr), where his father, the late Dr. Nilmoney Brahmachari spent the whole of his official career in the Medical Service of the Railway, being held in great esteem by both Europeans and Indians. The name, "Dr. Nilmoney" was a household word among the members of the staff of the East Indian Railway, even several years after his retirement from service.

Sir Upendranath took his B. A. degree from the Hoogly College in 1893 where he was awarded the Thwyates Medal for standing first in Honours in Mathematics. For sometime he could not make up his mind whether he should go up for higher studies in mathematics, chemistry, or medicine. This thought continued for sometime in his mind, even after entering upon his medical studies. And finally when he decided to study medicine with higher chemistry, he left mathematics with a sigh. The combination of the knowledge of higher chemistry with medicine no doubt helped him in his future researches. During the course of his studies in medicine in the first year he took his Master's Degree in Chemistry in 1894 from the Presidency College, Calcutta, in the first class, obtaining the University Silver Medal. He passed the M. B. examination in 1898 standing first in Medicine and Surgery for which he obtained the Goodeve and McLeod's medals. He passed the M. D. examination in 1902 and obtained the Ph. D. degree in Physiology in 1904, his thesis being *Studies in Haemolysis.* Sir Upendranath was a Coates Medallist and Winner of Griffith Memorial Prize of the Calcutta University, a Minto Medallist of the Calcutta School of Tropical Medicine and Hygiene and Sir William Jones Medallist of the Asiatic Society of Bengal.

Sir Upendranath's versatile knowledge and intelligence attracted the attention of the professors of the Medical College of Bengal, and after his graduation, many of his professors wanted him to be their

assistant. After hesitating for sometime he decided to be a physician. For a short time he worked under Sir Gerald Bomford who regarded him as a living dictionary of medicine. He was so much impressed with young Brahmachari's capacity for research and assiduity in the discharge of his duties that he very soon got him appointed as teacher of Pathology and Materia Medica in the Dacca Medical School. In Dacca he did researches with Sir Neil Campbell, Superintendent of the Medical School. Subsequently, he was appointed teacher of Medicine in the Campbell Medical School, Calcutta. He was elevated to this coveted post within a short period after entering into service. This post he occupied for nearly 20 years. He carried on most of his researches in kala-azar in the Campbell Medical School. It was here that he made his monumental discovery of *Urea Stibamine*. He retired from Government service as an additional physician in the Medical College Hospitals of Bengal. He was for sometime financed for his researches by the Indian Research Fund Association.

Sir Upendranath is one of the leading physicians of Calcutta ; President, Indian Science Congress, 1936 ; Professor of Tropical Medicine, Carmichael Medical College, Calcutta ; President, Indian Chemical Society ; President, Indian Committee, International Society of Microbiology ; President, Society of Biological Chemists, India ; Head of the Department of Bio-chemistry, Calcutta University ; Vice-President, Asiatic Society of Bengal ; Vice-President, Indian Association for the Cultivation of Science ; Vice-President, National Institute of Sciences of India, 1935 ; Member of the Syndicate and President of the Board of Studies in Medicine of the Calcutta University ; Chairman of the Board of Industries, Bengal. He is a Fellow of the University of Calcutta for upwards of 30 years ; Fellow, Asiatic Society of Bengal ; Fellow, Royal Society of Medicine, London ; Fellow, Royal Society of Tropical Medicine & Hygiene, London ; Hony. Fellow, State Medical Faculty of Bengal.

Sir Upendranath was President, Asiatic Society of Bengal (1928 & 29) ; Secretary, Medical Section, Asiatic Society of Bengal for several years ; President, Medical and Veterinary Section, Indian Science Congress (1930) ; Member, Council of Tropical Medicine and Hygiene, International Congress of Medicine, London (1913) ; member of the Council of Medical Registration of Bengal ; Member, Governing Body of the State Medical Faculty of Bengal ; Hony. Assistant Surgeon to the Viceroy and Governor-General of India ; President, Indian Provincial Medical Services Association.

Sir Upendranath has won for himself an international reputation as a research worker. Since the beginning of his official career he carried on extensive researches in connection with tropical diseases such as kala-azar, malaria, black-water fever, etc. He also made many contributions in chemistry. Some of his earlier researches were devoted to bio-chemistry and these were published in the *Bio-chemical Journal*. Recognizing his turn of mind towards bio-chemistry, Sir Ashutosh Mukerjee, Vice-Chancellor, Calcutta University, gave him a well-equipped room in the College of Science, University of Calcutta for his researches.

Early in his official career, he discovered in 1901 the prevalence of quartan fever in Bengal which was considered in those days to be extremely rare in India.

In the course of his researches in kala-azar he discovered colloidal metallic antimony and showed its therapeutic value in the treatment of the disease. He was the first to use successfully metallic antimony in a state of fine subdivision intravenously and of sodium antimonyl tartrate in the treatment of kala-azar. His subsequent researches in connection with the chemotherapy of antimonial compounds in kala-azar infection which were published in successive series of papers in the *Indian Journal of Medical Research* and which formed the basis of all subsequent modern treatment of the disease are well known. It is most creditable that he carried on his researches "in addition to his other heavy official and private medical work".

In the course of his research he drew attention to a remarkable undiscovered skin manifestation of the infection with Leishmania Donovani which was named by him dermal leishmanoid and which was previously mistaken for leprosy.

His most outstanding work is the discovery of *Urea Stibamine*, an organic antimonial which stands today pre-eminent in the treatment of and campaign against kala-azar and "has deprived the disease of its terrors". This discovery which "is a striking record of the value of well controlled research" is "a great work in the control of a terrible disease". Sir Walter Morley Fletcher, Secretary, Medical Research Council, once remarked during his visit to Assam. "I had the pleasure of seeing the organized use of Dr. Brahmachari's antimony compound (urea stibamine) in the treatment of kala-azar, and the great saving of life resulting from it". There is no doubt that urea stibamine is one of the most remarkable discoveries that have been made in tropical medicine during recent years. From a creative point of view, its discovery is as great as that of salvarsan and its derivatives by Ehrlich in the treatment of syphilis.

Sir Upendranath is the founder of the Brahmachari Research Institute and it is creditable to him that all his researches after his retirement from service are being carried on with his own private means without any financial aid from outside. Since retiring he has been carrying on researches in diseases such as kala-azar, malaria, the chemistry and pharmacology of quinoline compounds, and other subjects. His papers, after his retirement from service in 1927, numbering 35, have been published in the *Transactions of the Royal Society of Tropical Medicine & Hygiene*, *Journal of Pharmacology and Experimental Therapeutics*, *Journal of the Indian Chemical Society*, *Journal and Proceedings Asiatic Society of Bengal*, *Extrait du Comptes Rendus du Congress International de Medicine Tropicale et d'Hygiene*, *Indian Journal of Medicine*, *Journal of Tropical Medicine & Hygiene*, *American Journal of Tropical Medicine*, and *Indian Medical Gazette*.

His *Treatise on Kala-azar* is "the premier work on the subject." In 1926 he wrote the chapter on kala-azar in Dr. Carl Mense's *Handbuch der Tropenkrankheiten*.

As a teacher and educationist, Sir Upendranath's work has been of the highest order and he has worked to the best interests of the institutions to which he has been attached.

He has for upwards of 30 years striven to maintain the dignity and standard of teaching and examinations, as a teacher of medicine in Government service, as an examiner in medicine and science to the University, as a member of the Syndicate, as a member of the Faculties of medicine and Science in the University of Calcutta, and in framing the Calcutta University Regulations from the beginning of the Universities Act of 1904. As a member of the governing body of the State Medical Faculty of Bengal and of Bengal Council of Medical Registration he took a very prominent part in the framing of their regulations when these bodies came into existence.

As a philanthropist, Sir Upendranath has been doing great work. For his humane work, he was nominated Hony. Vice-president, Indian Red Cross Society. His charitable gifts amount to nearly two lakhs of rupees. Among the various institutions which have benefited from his philanthropy may be mentioned—the Asiatic Society of Bengal, Medical College of Bengal, Indian Association for Cultivation of Science, Indian Science Congress, Viceroy's Earthquake Relief Fund, His Majesty's Silver Jubilee Fund, Ashutosh College, Calcutta, Indian Red Cross Society, Lady Jackson's Darjeeling Victoria Hospital Fund, Board of Industries, Bengal, etc., etc.

We would quote a few lines from a speech of his in which he spoke of research workers as follows:

> "In dealing with research workers there should be no jealousy, no distinction of caste or creed, no differential treatment on the part of those who have the privileged position of recommending sanction of money for research. There should be only one object, namely, the well-being of mankind. No personal opinion or bias should retard the progress of scientific research, even if the attitude of a research worker be not to one's personal taste or inclination".

There is a bust of Sir Upendranath in the rooms of the Asiatic Society of Bengal, and a tablet with a plaque in the walls of the room in the Campbell Hospital where urea stibamine was discovered. This

tablet contains the following extracts from his presidential address at the Annual Anniversary Meeting of the Asiatic Society of Bengal, 1929-30:

"I shall never forget that little room where urea stibamine was discovered, the room where I had to labour for months without a gas point or a water tap, and where I had to remain contented with my old kerosine hurricane lamp for my work at night. The room still remains, but the signs of a laboratory in it have completely disappeared. To me it will ever remain as a place of pilgrimage, where the first light of urea stiba dawned upon my mind".

Obituary

Professor Sylvain Levi

It is with feelings of profound sorrow that the scholastic world has learnt the sad and sudden death of Professor Sylvain Levi. A great Sanskrit scholar and one of the greatest authorities on Buddhism, Professor Levi was born in Paris on the 28th March 1863, and educated at the Sorbonne. In 1886 he was appointed maître de conférence à l'École des Hautes Études and in 1889 chargé de cours à la Faculté des Lettres de Paris and it was in the following year that he wrote his famous work, *Le Theatre Indien* which brought him the degree of *Doctrat de l'Etat.* In 1894 he was appointed professeur au Collège de France of which he soon became the guiding spirit. During his sojourn in the East and India in 1921-23, he spent a few months at Shantiniketan where he delivered a series of lectures on Buddhism. The Calcutta University conferred on him the degree of D. Litt. *honoris causa.* In 1926 he was invited to Japan where he did some remarkable work and was appointed Directeur de la Maison Franco-Japonaise à Tokio. Professor Sylvain Levi was connected with many learned societies. He was a Member of the Royal Asiatic Society, London, and American Oriental Society, New York, and President of the Société Asiatique Paris. He was a linguist of repute and knew forty-five languages. Among his works mention may be made of *Le Theatre Indien, La Doctrine du Sacrifice dans le Brahmanas, Le Nipal* and *L'Inde et le Monde.* We hope to publish in a subsequent issue a detailed account of the life and works of the late professor.

Sir J. C. McLennan

Sir J. C. McLennan, K. B. E., F. R. S., whose obituary appears in *Nature*, Oct. 19, 1935, will be remembered by many friends in India. Sir J. J. Thomson records in the history of the Cavendish Laboratory that McLennan, Rutherford, and Townsend arrived on the same day at Cambridge, and were initiated into researches on the *Ionization of gases*, then being pursued vigorously at the Cavendish Laboratory. Of these, McLennan was a Canadian, Rutherford was from New Zealand, and Townsend from Ireland. It was an 1851 Exhibition scholarship which enabled McLennan to complete his research training in England.

McLennan was for long Professor of Physics at the University of Toronto, and the great physical laboratory there which bears his name was due to his energy and initiative. His contributions to physics were many and varied; probably the work by which he will be best known is his identification of the green line $\lambda 5303$, which is obtained in the spectra of night sky and the aurora. Formerly, it was ascribed to a hypothetical geocoronium, then to solid nitrogen. But McLennan obtained it in discharge through oxygen, and proved that geocoronium was none other than our old friend oxygen. Not only that, he traced it to the interesting forbidden transition $2p^4$ $({}^1D_2 - {}^1S_0)$. The discovery followed closely on Bowen's identification of nebular lines, and is extremely important for theories of the upper air.

McLennan with Rutherford discovered that closely shielded vessels get ionized spontaneously even when extreme precautions are taken for insulation. This is now known to be due to *Cosmic rays*, but the observation was not further pursued by the first discoverers.

An immense amount of work in different branches of physics was carried on by McLennan, and his pupils on spectroscopy, ionization potential of elements, and low temperature. The Cryogenic Laboratory at Toronto which is one of the best in the world was due to his energy and enthusiasm. After retirement he settled in England, but neither retirement nor age appeared to have diminished his activities.

Prof. McLennan acted as external examiner to many Indian aspirants after the doctorate degree, and the writer of this note had the privilege of making his personal acquaintance during the Volta Centenary at Como, which soon ripened into close and warm friendship. He will live in his memory as a kindly and general personality, always keeping a smiling face, and youthful enthusiasm for scientific work, and ready to help others in times of necessity.

M. N. S.

Notes and News

The Irrigation Department of Bengal

The Irrigation Department of Bengal have of late been making a very laudable effort in educating the public about the work done by the department for the welfare of the province. We need refer to the very useful and suggestive articles written for SCIENCE AND CULTURE by Mr. S. C. Majumder. The other officers are also following suit.

The Daily Press (*Amrita Bazar Patrika*, 22 October) published an article from A. Finlayson, Executive Engineer, Dredger Division, a summary of which is published above. Mr. Finlayson informs us that the Bengal Government possesses five dredgers which are mainly occupied in keeping the steamer routes clear by dredging river-channels which are being silted up. We would have very much appreciated if the writer gave some information about the capital expenditure on these dredgers and their maintenance charges. From the article it further appears that the dredgers have been very little used for any river-training work which will benefit the rural population of Bengal. Our information is that both the capital expenditure and maintenance charges are disproportionately high, regarding the work done by the dredgers, and they have very seldom been used for dredging rivers which will prove beneficial to the country side.

It may not be known to the public that the dredgers, Ronaldshay and Burdwan, were bought for excavating the projected Grand Trunk Canal which was to open up a shorter route from Calcutta to Eastern Bengal, at the initiation of the then Chief Engineer. The scheme was very adversely criticized by Sir William Willcocks, in his readership lectures to the Calcutta University, and also by Mr. Nalini Ranjan Sarkar in the Legislative Council. It appears that the scheme has been dropped, but the public would like to know what useful work has been done by these two dredgers all these ten years.

Mr. Madan Mohan Varman, a very active Councillor of the Calcutta Corporation, delivered a lecture in the Rotary Club on the drainage problem of Bengal, in which he referred to the opinion of a certain high officer of the Irrigation Department that the Hooghly is carrying less water than before on account of canalization of the Ganges and the Jumna in their upper reaches, and therefore the capacity of the Hooghly to carry away the sewerage of Calcutta has been diminished. We are simply astounded at the amazing ignorance shown by this high officer of the Irrigation Department, and it is in his interest that Mr. Varman does not reveal his identity. For it is well known that the deterioration of the Hooghli is due to the silting of the Bhagirathi, the Jelangi and the Mathabhanga at their off-takes from the Ganges (the Padma), and that the canalization of the Ganges and the Jumna in the United Provinces has nothing to do with it. The maximum flood discharge of the Ganges at Sarah is 2 million cusecs, and all this passes through the Padma Channel. If the mouths of the three rivers are cleaned and opened, and other steps are taken (*e.g.* by the building of a barrage as suggested by Willcocks) for diverting a part of the Ganges flood to Central Bengal, the Hoogly would greatly improve. We can assure our friend in the Irrigation Department that there would be no dearth of water in Bengal if more water is taken out of the Ganges system by canalization in the up-country, as the rainfall in Bengal is quite sufficient for keeping the rivers full.

Display of such amazing ignorance on the part of high officers shows that the organization of the Irrigation Department in Bengal is extremely defective. As a matter of fact, the problem of Bengal is not *irrigation*, but storage and equable distribution of water, and in some places quick discharge of water. This can be done if there be a River Section whose duty it will be to measure the discharges of waters throughout the year, follow the progressive changes in the rivers, and adopt intelligent remedial measures. In other words, knowledge must be obtained of all factors, and a ***synoptic*** study of such knowledge must be made before any great engineering scheme is undertaken. We submit that the Irrigation Department neither possesses such knowledge, nor

has the equipment to make such studies. Both in the past and at the present time, much public money is being wasted on ill-thought-out engineering schemes because of paucity of data, and lack of knowledge. In fact, the whole department should be overhauled and reorganized on a new basis.

Dredging of Bengal Rivers

Following is an abstract of an article, "Maintenance of Navigable Communications by Dredging," by A. Finlayson, Executive Engineer, Dredger Division, appearing in *The Amrita Bazar Patrika of* October 22, 1935.

In the communication system of Bengal, rivers play a much more important part than either railways or roads and so the upkeep of her river system is an extremely important matter for Bengal. Rivers in Bengal gradually deteriorate owing to progressive deltaic action, specially the cross channels (east-west) generally die out near the apex of the delta, and new ones are formed in the lower portions. The softness of the soil, tidal action, annual floods, slow oscillation of the river courses in the course of delta building, all these factors tend to make the river system of Bengal extremely impermanent and continuously changing. Yet it is of vital importance to the province that rivers be preserved in a suitable condition. The following are the methods usually utilized for the purpose.

(1) By handling.

(2) By the prevention and removal of obstruction to river and tidal flow.

(3) By preventing and the removal of existing embankments which hinder or prevent the natural spill action of rivers.

(4) By dredging.

The present article deals only with dredging.

The Government of Bengal possess five dredgers for clearing inland rivers and for the reclamation of swampy areas.

(a) *Ronaldshay :* 288 ft. long, can excavate 50,000 to 80,000 c. ft. per hour and can cut to a depth of 30 ft.

(b) *Cowley :* Sister ship to the above.

(c) *Foyers :* 260 ft., can excavate 35000—55000 c. ft. per hour, cuts to a depth of 25 ft.

(d) *Alexandra :* Somewhat smaller than the above.

(e) *Burdwan :* Smallest. For working in small canals near Calcutta.

The most important waterways generally maintained are what are known as

(a) The Calcutta and Eastern Canals.

(b) The Sunderbans Steamer Route.

(c) The Madaripur Bil Route.

(d) The Ganges, Pudda and Meghna Route with the numerous branch routes.

On account of the enormous cost involved in attending to these routes, Government has had to concentrate on preserving through communication, by repeated dredging, in the worst section of the routes.

(a) The section of the Calcutta and Eastern Canals near Calcutta has been dredged several times, but, on account of the cost and the the scarcity of dry land, dredging has only been done when the canal has deteriorated to such an extent as to obstruct traffic.

(b) The channel, which connects the Hooghly and West Bengal with the steamer route to East Bengal, known as the Doagra and the Hetalia Channels, has given trouble for many years, due to deterioration caused by the deposit of tidal silt. This has been dredged on several occasions.

(c) This route has always been the most troublesome and annual dredging has been done in the past in the Attarabanka and Lower Kumar Rivers in an endeavour to keep this line of communication open. In spite of this annual work these channels are closed for six months every year.

(d) In the Eastern Bengal routes, bhandalling is the main form of river training and dredging is only resorted to when the silting of the river tends to close the routes to traffic. Such work has been done in the past at Goalundo and Chandpore and in the Dhaleswari, Buriganga, and Lakhya rivers.

The above paragraph generalizes the work which is now being done by Government, with the funds available, to maintain these lines of communication. This effort is a losing fight and a time will come when new routes will have to be explored. To maintain these lines properly funds are required, as the cost

of such works is beyond the scope of ordinary Government revenue. Other sources of revenue must be explored. It is only fair that the people and the Companies, who would benefit directly from the improved channels, should pay.

Dredgers can also be profitably used in helping Nature to speed up her work of formation of new channels which invariably takes place in a deltaic area. When rivers are trying to establish a short cut through a loop, dredgers can help them. Besides, these vessels are very useful for removing practically any kind of obstruction, excavating entirely new channels through dry land, raising land levels, reclaiming swamps, raising river banks, and for improving a river grade in any way.

Public Health Commissioner's Report

According to the latest report of the Public Health Commissioner with the Government of India, there has been no violent disturbance in the Indian vital statistics. Both the birth rate and the death rate remain, except for minor fluctuations on either side, the same in 1933 as the average level recorded during the 33 years of the present century. But the infantile death rate, though during 1918-28 on a downward trend, has increased, so that since 1928 the annual figures for infant mortality have fluctuated only slightly between 181 per 1,000 births in 1930 and 169 in 1932, and the figure for 1933 again lies between these two contiguous limits. It seems that, for the present, the factors influencing infantile mortality are comparatively stable and that new and more rigorous measures, says the report, will have to be planned and put into execution before a further saving of infant life can be expected. No public health officer can look with any degree of equanimity on an annual death roll of nearly 1¾ million infants below one year of age and if, as has been repeatedly stated, the infant mortality rates of a nation provide an accurate estimate of its sanitary conditions, then India has little cause for satisfaction as regards the state of its public health. Regarding child welfare and maternity relief, the report points out that it has so far had little widespread influence except in restricted areas. The campaigns in these fields have only touched the merest fringe of the problem and much remains yet to be done to achieve its end by bringing down the infantile mortality now so appallingly high among the general population of rural India.

"The three main epidemic diseases, cholera, plague and smallpox, together caused 214,590 deaths but although this number is somewhat higher than in the previous year, owing to an increased prevalence of smallpox, the combined death rate was only 0.9 per thousand." Cholera was for the year only a minor problem, and plague which shows a reduced incidence although causing 43000 deaths appears to be gradually dying out; while deaths due to smallpox increased in a disconcerting manner from 4,500 in 1932 to 103,000 in the year under review, and the epidemic was fairly widespread over the whole of the Indian Peninsula. The present exacerbation after a series of years of comparative freedom from epidemic smallpox indicates how far India still has to go before this disease is satisfactorily controlled.

Malaria is responsible for a very large number of deaths. Of 12½ million diagnosed cases of the disease attended at hospitals and dispensaries during 1933, it exacted, it may be fairly estimated, a toll of at least 1,000,000 lives. The report lays particular emphasis on the high mortality due to this disease and goes on to point out that "year after year in India malaria is probably responsible for about 20 per cent of the total recorded deaths and many millions of the population experience periods of sickness which cause grave loss of earning power and much economic distress." It, therefore, suggests that larger quantities of quinine should be made available to the people than hitherto, "for it is difficult to suggest other means of succour to the millions who suffer from this deadly disease."

The report draws attention to the alarmingly rapid growth of population in the country. During 1933 the population of British India increased by more than 3 1|3 millions, and the estimated population at the midyear period was nearly 273 millions. There is no reason to think, says the report, that the same increase has not occurred in the Indian States. "This means that since the end of February 1931. nearly 18 millions have been added to the population of India and, on a conservative estimate, the total must now be approximately 370 millions, the calculated rate of increase being taken to be that recorded

during 1921-31." If the existing conditions continue—as it is likely that they will—there seems little doubt that by 1941 the population of India will considerably exceed the estimate of 400 millions given in the last year's report. The problem doubtless urgently demands further examination from an angle which has not yet been given sufficient attention.

The report says a few things, regarding the food supply of the country, which are not only extremely important but also demand our serious and immediate consideration. According to it, of the total of 667 million acres of land in British India during the year under review "only 232 million acres were cultivated and sown, 47 millions lying fallow, 154 millions being cultivable but uncultivated, 145 millions being not available and 49 millions consisting of forests. Even supposing the total acreage made up of cultivated and sown, fallow, and culturable but uncultivated lands were utilized this would work out to be 1.75 acres per head of the population. But some land must be allowed to lie fallow, an additional proportion must be given over to the cultivation of crops other than food and during 1933-34 the total acreage under food crops amounted to only 206½ million acres. "This gives only 0.72 acres per head of the population in British India and *it does not require more than an elementary knowledge of agriculture to realize that it is impossible to provide a sufficiency of food for the present population of India from an acreage of this dimension. It may even be held that, were all available cultivable land given over to food production alone, the supply would fall short of reasonable and adequate demand*" (italics ours).

"In order to forestall the usual argument, it can be admitted that the present shortage *might* be met for a short period of years by more intensive methods of cultivation, but that implies the immediate adoption of these intensive methods all over India and to those of us who know the village *ryot*, it is difficult to envisage a solution of the problem along those lines. Even supposing that additional food supplies were made available in this way, however, the difficulties would only be postponed for a few years, because the increased numbers of the population would rapidly absorb the surplus. Apparently, therefore, the problem of numbers in India is even more acute than before and it is one of such importance to the welfare of this country that it deserves immediate examination. Numbers are so intimately bound up with economics that the problem is one which affects every class of citizen. It is a question which will shortly force itself upon the attention of every man and woman in this country : it is to be hoped that it will receive adequate notice before disaster befalls."

Infant mortality and Tuberculosis in Bombay

According to the Bombay Municipal Administrative report for 1934-35, the mortality among infants under one year of age, during the year under review, was 8,253 as against 8,320 in the preceding year, giving a return of 245 per 1,000 births registered against the 269 in the preceding year. This shows that in the city of Bombay the percentage of infant mortality is higher than that of the whole of British India whose figure for the year 1933 lies between 181 per 1,000 births (as in 1930) and 169 (as in 1932). Diseases of the respiratory system, says the report, infantile debility and premature births accounted for 77 per cent, against 70.2 per cent in the preceding year. Infants below one month contributed 39.5 per cent, as against 36.5 per cent in the preceding year.

The report points out that the high infant mortality is not due to any abatement of vigilance on the part of the Public Health Department, but to the heavier incidence of diseases of the respiratory system and infantile mortality accentuated by poverty and illiteracy. Although the abolition of poverty is beyond the scope of the municipality, ignorance in the care and nature of chidren, we are informed, is being strenuously fought.

Tuberculosis accounted for 1,856 deaths against 1,594 in the preceding year. The death rate from this disease was 1.6 per 1,000 population, against 1.4 in the preceding year. The incidence was noticeably heavy in the age group between 20 to 40. It was also marked among Hindu men and Moslem women, in the former "probably due to poverty and its attendant evils, and in the latter due to the purdah system." Anti-tuberculosis measures continued unabated. The total attendance at the two out-patient tubercular dispensaries was 13,153, and the total number of inpatients treated at the Turner Sanatorium (32 beds) was 201. Treatment at the sanatorium produced improvement in 76.7 per cent of the cases discharged.

Malaria, according to the report, was responsible for 101 deaths against 71 in the preceding year, but, says the report, "malaria is a disease of more widespread incidence than is indicated by mere deaths from it. The number of attacks is, therefore, a more accurate index of its intensity. The number of cases treated in municipal dispensaries was 1,931 and in the other public hospitals 19,750, against 1,107 and 12,004, respectively, in the preceding year. The cases treated by private practitioners are difficult to account for in the absence of any statistics; their number must be also large. The figures for the year thus show an unfortunate set-back in the improvement hitherto noticed. The Executive Health Officer (Dr. J. S. Nerurker) is, therefore, of opinion that any further retrenchment in the Malaria staff cannot but be disastrous to the city."

Department of Industries, Bengal

From a press note issued by the Government we learn :

That the Industries Department of the Government of Bengal responded in an adequate measure to the call upon their services in the matter of research is amply borne out by activities of its different branches during the year. An important condition of industrial advance is continuous research, making available to industrialists, particularly to the smaller ones who cannot afford to have research sections of their own, the most up-to-date methods of manufacture and the activities of the Department tended to foster this condition.

The soap industry came in for considerable attention, for India is in the front rank of the oil seed producing countries of the world and soap-making is an industry which is capable of consuming vast quantities of vegetable oils of all kinds; besides, the industry has already a vast and expanding home market.

The researches of the Department were therefore directed both towards investigation on raw materials and on improved technical process. Though the work done in this line has of necessity been limited more or less to the nature of a provincial inquiry, as many as six varieties of oleaginous seeds capable of profitable industrial use have been discovered.

Researches have shown that in the Nahor, popularly known as the ironwood or lohakath tree, Bengal has seeds which, in the dry state, have the amazingly high oil content of 80 per cent.

The reverse graining process evolved by the Department has largely succeeded in eliminating colour defects from soaps made from indigenous materials while its investigations in charge computation have led to the discovery of a new method which makes it possible to keep the detergent power of the soap at the maximum or any desirable point under varying conditions.

The maximum benefit cannot however be expected unless other industries capable of consuming large quantities of oils are established. The Department is accordingly preparing the ground for another set of important industries making considerable use of a particular class of vegetable oils. These are the varnish and allied industries using drying oils together with gums and resins -another class of natural products abounding in India.

In the engineering section the Department's activities were directed towards the evolution of new processes of manufacture which could revitalize the small and cottage industries of the province. Thus, in the brass and bell metal industry, the manufacture of less complicated building and sanitary fittings and the casting of tea and table spoons and other articles made of German silver have been standardized, while an improved blowing arrangement and a new type of floor furnace evolved by the Department are already growing popular among small industrialists because of the reduction in capital cost, low consumption of coke and economy of time in melting. In the umbrella industry experiments have been successful in standardizing the use of polo and root canes as basic raw materials for umbrella handles. The manufacture of scissors which are sold in large quantities throughout Bengal has been standardized and a double chamber furnace with natural draught has been evolved which enables tempering and hardening to be carried on even in the mofussil, while experiments on various specimens of steel for use in the manufacture of the better known types of cutlery on a paying basis are in progress.

Progress in pottery manufacture is being accelerated with the construction of a new type of cheap and satisfactory kiln and the evolution of new processes

of glazing for ornamental pottery, which is in great demand.

Slate pencils, which are in considerable demand, came in for attention and a machine has been designed and constructed which rolls out slate pencils intended to be manufactured by the synthetic process. Encouraging results have been obtained.

The efforts of the weaving section in popularizing improved appliances have succeeded to such an extent that the country weaver is no longer satisfied with his old fashioned equipment. Not a little of this success is due to the demonstrations arranged by this section and the sale of improved appliances at cost price to cottage weavers. The designs worked out by the Department for mixed woollen *saries* and wrappers are also finding favour with the public.

The leather industry is developing fast and is already attracting middle class youths. The Bengal Tanning Institute's investigations in regard to the selection of raw materials, pickling, tanning, pigment finishes, shoe polishes and creams and on manufacturing processes have proved a boon to the trade.

The Department has also freely given information to those who sought its aid on commercial and industrial matters, found markets for local products, encouraged industries by securing for them special concessions and placed at their disposal technical assistance and advice.

Electricity Charges : Views of I.C.C.

Below we give some extracts from a circular letter in which the Indian Chamber of Commerce, Calcutta, has expressed its views on electric charges at Calcutta.

At the outset the Committee feel that a Public Utility Company like the Calcutta Electric Supply Corporation which enjoys a monopoly should consider it as its imperative duty to charge its various consumers as low a rate as it is possible to do. The Committee also cannot help feeling that the charges levied for electric energy supplied to consumers by the Electric Supply Corporation at the present time are exorbitantly high and such as can bear considerable reduction while still distributing a more than reasonable dividend to the shareholders of the Calcutta Electric Supply Corporation.

An analysis of the Balance Sheets of the Calcutta Electric Supply Corporation would doubtless show that it has been consistently increasing its reserves, its dividends and has also been issuing bonus shares. It issued bonus shares in the year 1927 in the ratio of 1/10 of ordinary shares. The total issue in respect of bonus shares was 136,671 shares of the nominal value of £1 each. The Reserve Fund of the Corporation in 1920 was £155,911-11-6. By 1932 the Reserve Fund (including premiums on ordinary shares £155,049-6-4) rose to £1,120,841-16-7. The capital in 1920 was £1,655,000 as against £3,404,580 in 1932. The Committee of the Chamber have perused the summary balance sheets of the Electric Supply Corporation for the years 1920-32 and they desire to submit the following reasons to prove that the charges levied from the consumers may be considerably reduced. The object of the Electric Supply Corporation, a monopolistic concern, cannot be, as it has been, of profiteering, like ordinary commercial concerns. Further more, the Corporation never stands the risk of incurring a loss as is confirmed by the fact that even in the years of the worst economic depression it has been able to make huge profits and distribute high dividends among its shareholders. The shares of the Corporation are as good as giltedged securities and there is no reason why the dividend thereon should exceed the rate of interest paid on Government loans.

The Calcutta Electric Supply Corporation has declared *dividend as high as* 13% for the last three years. This in the opinion of the Committee is too high. Considering the present market conditions and the dividends declared by limited concerns engaged in various businesses and the rates of interests in Securities as well as investments, the Committee of the Chamber firmly believe that for a public utility company like the Calcutta Electric Supply Corporation, which has not to face competition and in which chances for loss are nil, the dividend need in no case exceed 6% on its ordinary share capital. That this rate of dividend is not low is testified by the fact that whenever public electric supply companies are floated under the guarantee of Local Bodies, *the dividend guarantee never exceeds* 4%. The Committee are informed that in Nagpur where the Electric Supply Co. declared a dividend of 6%, the Government conducted a special enquiry and pressure was brought upon the Company not to declare such high dividends

in future, and to reduce the electricity charges for the benefit of consumers. The same thing happened in case of the electric supply company at Hooghly. These cases will clearly show that a dividend of 6% for the Calcutta Electric Supply Corporation is absolutely reasonable. Calculating the dividend on the basis of 6% return on the Ordinary Share Capital, the Committee of the Chamber find that the Calcutta Electric Supply Corporation will effect a net saving of about £1,46,351 yearly.

Converting the above sum of £1,46,351 into pies, it will come to a net saving of 38 crores of pies. The total number of units sold to the flat rate users in 1934 was 47,413,217 units. This will result in a saving of 38 crores of pies on 4.75 crores of units, *i.e., a saving of about 8 pies per unit.* It will thus be clear that if instead of distributing the present dividend of 13% in total, the Electric Supply Corporation distributes a dividend of 6% which appears to be more than fair and just, it is possible to reduce the flat rate charged to the consumers for 4.75 crore units sold during 1934 by about 8 pies per unit, *i.e.,* it is possible to bring down the charge from annas 2 pies 6 as at present to As. 1-10 ps. per unit on this account alone.

Another means, which the Committee desire to suggest, for effecting a reduction in the charges levied by the Calcutta Electric Supply Corporation is by *reducing the amount of depreciation charged at present.* The Committee find that the Calcutta Electric Supply Corporation charges a huge amount of £2 lakhs as depreciation every year on its plants; but they are not aware as to whether in the depreciation thus charged, the Corporation also includes discarded turbines which have been replaced by new ones as well as the discarded plant and machinery. If this depreciation of £2 lakhs is reduced to £1 lakh, which in the opinion of the Committee is feasible, the saving of £1 lakh effected thereby, may be utilized in reducing the charges on the consumers by nearly 6 pies per unit further. The committee of the Chamber would therefore suggest that the Advisory Committee should carefully investigate the items on which the Corporation charges depreciation and should also see as to whether block capital consists of discarded machinery or other items for which provision for depreciation need not be made. If this contention be found to be correct, the flat charge should not exceed 1 anna 4 pies per unit.

The Committee would also suggest to the Enquiry Committee to make a careful investigation into the administration expenses incurred by the Calcutta Electric Supply Corporation, which appear to be very heavy.

The Committee regret that they are not aware of the exact cost of production of electricity by the Calcutta Electric Supply Corporation. On making enquiries from various private concerns that are generating their own current, it is found that the cost of generating current including the amount of depreciation in case of a plant of 2,000 Kws in or near Calcutta comes to about 2.5 pies per unit. The Committee are therefore led to believe that the cost of generating electricity including depreciation cannot exceed 2 pies per unit in case of the Calcutta Electric Supply Corporation having a huge plant of 50,000 Kws. This cost does not include the transmission loss, but even making a liberal allowance for it, it is difficult to see how it could exceed another 2 pies per unit. It may be expressly pointed out here that the cost of laying down cables etc., for distribution is included in the Blocks and the 2 pies per unit, mentioned by the Committee should include all costs of distribution and transmission loss and mains etc. The total cost of current supplied to the small consumer would thus amount to 4 pies per unit. Confirmation of this may be had from the statement made by MR. CHOKSEY, Chief Electric Engineer of the Calcutta Electric Supply Corporation, in his deposition before the Hon'ble Mr. S. L. Sinha, the Chief Presidency Magistrate, in the Electricity Theft Case, *that for each unit of current lost, there was a loss of one-half anna to the Company.* Doubtless this figure includes the cost of generating current, depreciation as well as transmission loss. Further confirmation may be found from the rate charged from big industrial consumers, which is some times *as low as 3 pies per* unit. Surely current cannot be supplied to them at a loss, although it may be contended that in consideration of the larger consumption by the various industrial concerns, they can be given a reduced rate. But it cannot be denied that the cost of production on account thereof has consider-

ably gone down. The Committee learn that the average selling price on the total units consumed at Serampore, both Industrial and domestic, is about half an anna per unit. This leads to the conclusion that the cost of generating as well as distributing current at Serampore in the case of Calcutta Electric Supply Corporation Ltd. is very well below one-half anna per unit, though Serampore is 17 miles away from Calcutta. If to half an-anna per unit, a reasonable amount may be added for the Calcutta Staff of the Company, for dividend to the shareholders, and for addition to the Reserve, it is difficult to understand why the flat rate to the domestic consumers should exceed one anna or one anna and three pies per unit at the most. The Committee trust that the Enquiry Committee will consider this question carefully. The usual argument advanced by the Company that the Calcutta charges are low as compared to other places has neither any relevancy nor any force, particularly when the figures of the cost of production, distribution, dividend, etc. show that a considerable reduction can be and should be made for the benefit of consumers of electricity.

The Patwar Meteoric Shower

Dr. A. L. Coulson reports as follows concerning *The Patwar Meteoric Shower of the 29th July, 1935* :

At the September meeting of the Asiatic Society of Bengal when certain additional stones of the Perpeti meteoric shower were exhibited (see SCIENCE AND CULTURE, I, No. 5, p. 280), mention was made of the reported fall of a meteorite near Nangalkot in the Tippera district of Bengal. As a result of enquiries made by the Geological Survey of India, it has since been ascertained that at about 14.20 hours on the 29th July, 1935, a meteoric shower occurred near the villages of Patwar (25°9′: 91°11′) Batupara Gotrasal, Fatehpur, and Majhipara, near Nangalkot, some 20 miles due south of Comilla, the chief town of Tippera district. Patwar is only some 17 miles south-east of Perpeti, also in the Tippera district, which is the locality of the shower referred to above. The two falls, however, are distinct, but it would be interesting to learn of any other occurrence of two separate meteoric showers within 17 miles of each other after a lapse of two and a half months.

Five specimens, of a total weight of 37,353.3 grams were recovered, the three largest stones weighing 23,111.6 grams, 8,755.7 grams and 3,146.2 grams respectively. The largest stone fell at Patwar which village gives its name to the fall.

The fall was accompanied by the usual phenomena of light and sound. A dazzling light following a 'loud rumbling noise' is supposed to have been the first indication to the villagers of the fall of the meteorite. The sound is stated to have been so loud and continued that those in the police thana at Chanddagram, some 7 miles to the north-east of Fatehpur, the nearest locality to the thana from where stones were recovered, distinctly heard it. Four reports 'like thunder' were heard in quick succession. One observer adds that a peculiar sound like 'that of an aeroplane' followed the reports; this may have reference to the passage through the atmosphere of the disrupted members of the parent meteorite.

The largest specimen penetrated the ground to a depth of 34 inches.

The parent meteorite appears to have been moving in a west-south-westerly direction. The smallest pieces fell first, followed in succession by the larger. The total rectangular area covered by the shower is roughly about $4\frac{1}{2}$ square miles, the length being some three miles in the direction E.S.E. W.S.W.

The meteorite has great interest on account of its rather rare composition. It belongs to the group of mesosiderites, being a siderolite intermediate in composition between a stone and an iron. It contains large crystals of olivine and masses of nickel iron of fair size. It is composed chiefly of nickel iron, with olivine, enstatite and bytownite, with smaller amounts of schreibersite, troilite, oldhamite, lawrencite and hydrocarbons. Its specific gravity is 4.21.

The Patwar mesosiderite will be described in a paper appearing in the *Records* of the Geological Survey of India. The specimens were exhibited by permission of the Director, Geological Survey of India, at the November meeting of the Asiatic Society of Bengal.

Excavations at Patna

Recently the trial excavations carried out by the Archaeological Superintendent of the Central Circle, Patna, near Patna, have led to various discoveries of ancient relics, and various accounts of the same

have appeared from time to time. Regarding this a *communique* has been published, which runs as follows :

" Various conflicting reports have recently been published in newspapers about the trial excavations carried out by the Archaeological Superintendent of the Central Circle, Patna, in a brick field locally known as Gousai Khanda situated near the Arzani Dargah to the north of the road to Kumrahar and Bulandibagh near Patna.

" In order to give a correct idea of this work carried out recently by the Archaeological Department the following account is published :

" On receipt of a report from the Chaukidar at Kumrahar that traces of some wooden structures had been exposed in a brick field, the Archaeological Superintendent proceeded to examine the nature and extent of the ancient remains by trial diggings. The result was the dicovery of a long wooden platform, about 100 feet in length, 5 feet 6 inches in width and 7 feet in height running north and south. The bottom of this structure is 22 feet below the level of the road nearby and seems to continue at either end. Wooden structures were unearthed previously at the Bulandibagh and Kumrahar excavations by the Archaeological Department, and another has recently been brought to light by the Public Health Department in course of laying sewage pipes to the east side of Kankarbagh Road.

" The minor antiquities found at Gousai Khanda consisting mainly of small pottery cups, potsherds and terra-cotta balls, etc., are similar to those discovered at Kumrahar and Bulandibagh and may be attributed to the Mauryan epoch. A small walling of Mauryan bricks was also found at right angles to the wooden structure near the top.

" The particular purpose for which all these wooden structures at the ancient site of Pataliputra were constructed is not determined. The Bulandibagh pieces might well have formed part of the old wooden palisade of Pataliputra, but the Gousai Khanda construction is more likely to be a coffer dam erected in connexion with training and revetment of a river bank or the construction of a wharf.

" The favourable situation of ancient Pataliputra at the confluence of the Son and the Ganges made it a great centre of inland water-borne traffic, and there must have been a river port of considerable importance at Pataliputra, and wharfs and docks must have been found necessary, where such coffer dams of which the remnants have been laid were sometimes constructed."

Archaeological finds in North Bihar

A press report says that various articles of archæological interest have been discovered near Darbhanga in North Bihar on the banks of the Bagmati.

In the remains of an ancient building near Kalighat, surmised to be the remains of an old Buddhist Vihara, an engraved figure, an image of Vishnu, a fossilized relic covered with mica containing fossilized rice, a clay seat and a clay toy, shells, mica pieces, sculptures, stone pillars and slabs were among the many articles found. Images of Buddha, Shivalinga and Durga have also been found.

Mulagandha Kuti Vihara

The fourth anniversary of the Mulagandha Kuti Vihara was celebrated with great enthusiasm at *Isipatana (Sarnath)*, Benares, on Sunday the 10th November 1935. Over 100 Buddhist Bhikhus including four from Germany came from outside India to attend the function.

On this occasion the Director General of Archaeology in India presented the Holy Relics of Shri Lord Buddha discovered at Mirpur Khas (Sind) on behalf of the Government of India.

In the course of his address, the Secretary of the Mahabodhi Society spoke about the scheme of a Buddhist University on ancient line like Nalanda and said, " We have up till now only succeeded in forming an association known as the International Buddhist University Association with the Hon'ble Justice M. N. Mukherjee as president and Anagarika B. Govinda, a German Buddhist, as General Secretary to carry out this proposal."

An Industrial exhibition was also organized on the occasion. The opening ceremony was performed by Bhikhu Anand Kaushalavan.

Expedition into Tibet

After a stay of two and a half months in Tibet where they had gone on a scientific expedition, Mr. A. S. Vernay, a trustee of the American Museum of Natural History, New York, and Mr. C. Suydam Cutting, his field associate, brought with them a large collection of anthropological, natural history, and botanical specimens which will be distributed between Kew Gardens, London, and the New York Botanical Garden. In Tibet the expeditionists endeavoured to make a general photographic survey by means of moving and still pictures, of which they possess a large number, so that these will enable us to form an accurate idea of conditions of Tibet, the customs of the people there and their mode of living. The whole of their travels in Tibet was by caravan, covering over 1200 miles, many of the places visited being off the beaten track. Mr. Cutting had been in touch with the late Dalai Lama for the last five years and they were permitted to enter Tibet through his friendship.

Bronze Age Village in Hungary

Excavations during the month have brought to light a Bronze Age village in Hungary (*c.* 1000 B.C.), and, nearer home, what is believed to be the remains of a human skeleton of an age comparable with that of the Peking Man, in the Thames gravel near Gravesend. The importance of this find, it is hoped, may be equal to that of the Peking Man, unearthed, in Sussex some thirty years ago. At Jericho, Professor Grastang reports the discovery of baked and unbaked clay statuary from a level far below that of the biblical city, showing a very high standard of artistic representation. *The Discovery*, November, 1935.

Coffins of Unknown Tribes discovered

What at first seemed to be only in the imagination of his informer came later, on personal inspection, to be true when Mr. V. P. Sondhi of the Geological Survey of India, during his tour in the Southern Shan States, came upon a cave full of coffins and bones of an unknown tribe of men. When his informer told him about the existence of the coffins, the story appeared to Mr. Sondhi incredible at the time as not only was no present tribe known to dispose of its dead in that manner, but the transport of heavy coffins to the cave, which is situated in the middle of a sheer cliff some 500 feet in height, seemed to him impossible. Though many beliefs among the villagers are current about an unknown tribe of men dwelling in the thick of woods, there was no way of proving the existence of these. Mr. Sondhi visited the cave a second time, now with four Europeans only to be confirmed in what he had seen before. This time it was found that the cave had been raided since Mr. Sondhi's first visit. There were 30 to 40 coffins in the portion of the cave visible to the party. They were all carved out of solid logs of teak and the outer surface was levelled with short chopping strokes rather than with a saw. A curious feature of the bones collected was that almost all the long ones, those of the legs, were roughly cut or scraped at more or less the same position at the two terminals. The parallel narrow grooves and lines were like those produced by the gnawing of rodents, but it was suggested that these cuts might be a post mortem mutilation by a human agency representing some kind of a burial ritual of a particular tribe. The whole thing is not only vastly interesting, but clouded in mystery. The puzzling problems are: how were the coffins transported to the cave, and how did the bones come to be mutilated?

Writing on this in *The Statesman*, 'a correspondent' says that this is not the first time in the history of anthropological research that a similar find has been made. Exactly 10 years ago, an almost identical discovery was made on the east coast of Borneo by a Mr. Creagh. He visited some caves in a limestone hill on the left banks of the Kinabatangan river in British Boreneo. The existence of these caves had been unknown to the Europeans of the district till a year before Mr. Creagh's visit. When Mr. Creagh investigated them, he found they had been used as burial places by a former race of inhabitants of whom none of the present settlers or traders on the river could give any information. The similarity between the two finds is most remarkable not only as to the objects found but also as to the circumstances in which the discovery was made. In this connexion it should not be forgotten that all over Asia there is a large body of tradition speaking of hidden and unknown tribes. The subject drew special interest a few years ago when reports were brought back by

Mount Everest Expeditions about the "abominable snow men." Investigations were made and it was found that not only in Asia but also in Africa and America similar stories were current. A systematic search was inaugurated to collect the available data by one of the members of the Asiatic Society of Bengal and large amount of materials was gathered. The investigation is still being pursued but though varied data have come to hand, final conclusions cannot be formulated as yet.

Facts, legends, and superstitions may all be mixed up in the making of tradition and it is now for the anthropologist to sift the evidences and arrive at definite conclusions.

U. P. Electrification Scheme

The United Provinces Legislative Council will, it is reported, consider an important scheme costing eventually Rs. 20 lakhs, which will benefit the eastern districts of the province. The scheme will provide for the pumping of water by means of a steam turbine plant from the Gogra and Gumti rivers with the object of irrigating several thousand square miles of cultivable, though at present unprotected, land in the Fyzabad, Sultanpur, Jaunpur, and Partabgarh riverine tahsils. Neighbouring towns will be provided with power for lighting and for minor industries from the surplus power available.

The initial capital involved will be a little over Rs. 3 lakhs, for the electrification of Fyzabad. Later, Rs. 17 lakhs more, which is estimated to yield 12.5 per cent. will be involved. This scheme will be worked in co-operation with the rural development schemes and is intended to cover the whole eastern part of the province by establishing generators at strategic centres.

Electricity Board for Madras

The Madras Government have appointed a committee with the Law Member as chairman to examine the suggestion that a statutory board be constituted for the control and administration of all matters connected with the supply of electricity in the presidency.

The following are the terms of reference : (1) To examine whether the existing arrangements for generation and distribution of energy in the Presidency as a whole and for the administration and control of company and municipal undertakings are efficient and satisfactory and if not whether they are such as to retard progress of electrical development generally to the detriment of industrial expansion.

(2) To consider and report (a) what steps should be taken to ensure adequate and economical supply of electric power for all classes of consumers in the Presidency; (b) whether the constitution of a statutory board like the Central Electricity Board in Great Britain or the Electricity Supply Commission in South Africa or similar bodies elsewhere to take over control and administration of electric supply, is desirable or necessary; and (c) what should be the constitution and powers, administrative and financial, of such a body.

The Government hope that the committee will find it possible to commence sittings in the last week of November at the latest and to submit a report not later than May 1.

- *The Statesman.*

Cancer Hospital for Bombay

The Trustees of the Sir Dorabji Tata Trust have decided to erect a modern cancer hospital at Bombay. For some years the Trustees have been studying the need for such an institution in Bombay and have consulted experts in England, America and the Continent in regard to the preliminary plans. For the last two months an American expert has been surveying the Bombay situation, and his findings have now been accepted by the Trust as a method of procedure.

The plans call for the erection of a modern hospital and the use of the latest methods employed in cancer treatment. While radium will of necessity play an important part in the treatment, the new hospital will not simply be a Radium Institute. Surgery, X-rays and all other known methods of effective treatment will be employed.

The hospital will be an independent institution, specializing in the attack upon cancer and allied diseases. Provision is being made for the treatment of both free and paying patients; an out-patients department will also be maintained.

The Trustees have appointed Dr. John W. Spies of Harvard as the first Director of the hospital. He has had extensive experience in pathology, surgery and radiology. In addition, the new Director was

recently in charge of the Tumour Clinic, attached to the Department of Surgery of the Peking Union Medical College. Prior to that he was associated with the Memorial Hospital in New York, America's foremost Cancer Hospital, and was a Member of the Faculty of the Yale University Medical School. Dr. Spies has travelled extensively in order to acquaint himself with the leading American, European and Japanese medical centres—especially those renowned for cancer work. He is a member of several important societies. Dr. Spies is now in Bombay working on the provisional plans for the new hospital, and it is expected that the centre will begin work some time in 1937.

Crop Planning

In pursuance of the recommendations of the crop planning conference held in Simla in the summer of 1934, the Government of India, it is understood, have settled all the preliminaries for the appointment of two Standing Committees of the Imperial Council of Agricultural Research one on rice and the other on wheat.

The functions of these two committess, which will be constituted under the rules and regulations of the Council of Agricultural Research will be advisory and they will help research work on rice and wheat from the agricultural, scientific and economic points of view.

New Use for Shellac

The Indian Lac Research Institute has discovered that a shellaced surface, on treatment with certain chemicals, attains very soon hardness and power to weather resistance. Although the process has not yet been perfected, it has great commercial possibilities, and considerable interest is shown by German chemists in this new line of enquiry.

Industrial Developments in China

The rapid growth of chemical research, both pure and applied, in China during the last decade is phenomenal. Twenty years ago the number of research papers did not exceed two on an average, to-day the number of papers originating from China exceed 150 per year. Research institutes are springing up everywhere, and new industrial enterprises are being undertaken. In Peiping a laboratory has been organized to prepare special synthetic research chemicals, and the Central Glass Company of Shanghai has started domestic production of laboratory glassware. The Yung-Li Company, a Chinese concern, which operates the Solvay Soda Plant in Tangku, is constructing a large scale plant for the fixation of atmospherin nitrogen at Pukon.

Cheaper Fire Extinguishers

An officer of the Hyderabad Fire Brigade is reported to have discovered new and cheaper materials for the manufacture of chemical fire extinguishers. The chemicals are a mixture of aluminum sulphate and a saponine like substance. They are non poisonous, cheap, and easily obtainable, and not harmful to even delicate materials. Practical experiments proved to be very satisfactory.

Deutsche Akademie

The scholarships of the following Indian students were continued by the India Institute of the Deutsche Akademie for another term :

(1) V. G. Menon, Technical University of Munich; (2) A. K. Mitra, University of Munich; (3) B. K. Kar, University of Leipzig; (4) K. P. Mukhopadhyay, University of Heidelberg; (5) N. I. Khan, University of Bonn; (6) P. Narayanamurthy, Technical University of Danzig; (7) A. K. Ghose, Technical University of Dresden.

Rural Broadcasting

Lt. Col. H. R. Hardinge of the Indian Village Welfare Association who is now touring India studying the rural aspect of the radio question says in course of a statement to the Press : My object was to tour the country preaching the gospel of rural broadcasting in India, and the first materialization of my endeavours was the experimental rural broadcasting service at Peshawar undertaken by the Government of the N.W.F.P. The success of that experimental scheme is now widely appreciated, nevertheless there now appears to be a danger of the reversion to the former line of thought, namely, that broadcasting in India should be developed upon principles similar to those found appropriate in Western countries.

The need of additional broadcasting stations suitably situated to disseminate programmes in the appropriate dialects, devised specially to serve a local rural population, must not be lost sight of. Such stations of lower power will serve also as relays for those portions of the central programmes as are considered suitable for the rural population: that is to say, musical items, general and commercial news, time signals, or special broadcasts of topical items of universal importance or interest. But without doubt the items that are destined to serve the great purpose of educating the villager—the simple, homely talks upon the fundamentals of health, co-operation, thrift, agriculture and the like—will have to be given more programme time than a central station can afford to devote to such subjects, having regard to the difficulty of diversity of dialects, not to mention that much of the rural programme matter will be objected to as uninteresting by the urban and suburban listeners.

Since individual ownership is, generally speaking, out of the question in the rural areas on account of the poverty of the peasantry, the only possible way of giving broadcast programmes to the villages will be by way of community receivers. Such receivers have of necessity to be specially designed for the purpose, and their maintenance will be a matter of demanding a great deal of capable organization and administration.

Safe Artificial Sunlight

At the 29th annual conference of the American Illuminating Engineering Society, at Cincinnati, last month, an electric light bulb developed by Dr. George S. Sperti, which radiates "*sunshine*" with complete freedom from the danger of excessive sunburn, was shown for the first time. According to an announcement issued by the General Foods Corporation, protection against rickets in children and against results of calcium deficiency in adults can now be given by irradiation without incurring the risk of over exposure.—*The Electrician.*

Petrol from Coal

The coal hydrogenation petrol plant of Imperial Chemical Industries Ltd. was recently opened by Mr. Ramsay MacDonald, the Lord President of the Council, at Billingham. Research work to perfect the technique on which the plant work has been carried on since 1927 and is estimated to have cost I.C.I. about £1,000,000. But the technical difficulties were all gradually overcome and it was decided to construct a plant to work the process on a commercial scale in 1933, when the National Government announced the British Hydrocarbon Oils Production Bill. This Bill guarantees a preference to home produced light oils for a certain number of years. The plant can produce petrol at the rate of 410 tons or 123,000 gal. a day, and can utilize creosote oil or tar as raw material besides coal. Though the Billingham plant can supply only 4 [illegible] of the country's consumption of petrol, the industry is considered to be of national importance: firstly, because it would help the coal mining industry to a considerable extent, and secondly, because it would be highly useful at the time of war when the foreign petrol supply may be endangered.

Indian Lac Cess Committee

The Indian Lac Cess Committee invites applications from persons experienced in the conduct and direction of chemical and biological research on natural products, for the post of Director, Indian Lac Research Institute, Namkum, Ranchi. Salary Rs. 1,250-50-1500, initial pay according to qualifications and experience. Five year contract subject to a year's probation, Provident Fund, rent-free house.

Qualifications.—High academic qualification in chemistry will be required with special knowledge of organic and analytical chemistry as applied to industrial problems. Experience of the direction of chemical research on natural products and of administration essential. Special knowledge of the chemistry of the natural and synthetic resins and of plant biochemistry will be additional qualifications. Applications from Government servants will be considered if supported by official superiors. Other things being equal, preference will be given to an Indian candidate. Further particulars and application forms obtainable from the Secretary, Indian Lac Cess Committee, Main Road, Ranchi, B. & O. Last day for applications 14th December 1935.

Research Notes

Oedipus Complex in Anthropology

Psycho-analysis must now be regarded as indispensable for the study of the evolution of human culture. The fact that orthodox anthropologists like Professor Westermarck and Pater Schmidt have taken pains to controvert, in their own way, its conclusions show that it is a factor which can no longer be disregarded.

It has been said that Oedipus Complex is the powerful locomotive that has driven Freud's victorious chariot across the world. Applying the principles of this Complex to some 'pre-logical' customs of humanity, Mr. Paresh Chandra Das Gupta arrives at some interesting conclusions in *Man in India*, April-September, 1935. After a brief summary of Freud's theories on the subject, he proceeds to consider some primitive customs, *e.g.* the avoidance of brother and sister in Melanesia, of the mother-in-law and son-in-law and of the elder brother and the younger brother's wife in Bengal. In these cases the female relative becomes the substitute of the mother, the object of Oedipus, and as such tendencies have to be abandoned owing to their incompatibility with the dictates of the super-ego, the libido concerned is converted into fear.

In his *Totem and Taboo* Freud has laid stress on the ambivious feeling which the son bears to the father. By an extension of the same principle the mother too will have a similar feeling towards her husband. At the death of a man, therefore, the *id* is satisfied, but the super-ego exerts its authority over the ego and makes it remorseful. This, according to Mr. Das-Gupta, explains the various self-tortures which the widow and the son have to undergo at the death of a man, *e.g.* shaving, fasting and, in more extreme cases, cutting the fingers and *sati*.

Head-hunting too, according to Mr. Das Gupta, symbolically represents the Cyclopian murder which, Freud says, stands at the threshold of human civilization.

A. Ghosh.

Active Nitrogen

The phenomenon of active nitrogen has been familiar to scientists since the beginning of the current century. Warburg and E. P. Lewis found in the beginning of the current century that when a condensed discharge is passed through flowing nitrogen gas, the gas continues to glow with a pale yellow light even in the regions where the discharge is no longer operative. Later, active nitrogen has been produced by electrodeless discharge. Lord Rayleigh II and A. Fowler found on spectroscopic analysis that active nitrogen is nothing but molecular nitrogen excited by the discharge. But the active modification possesses remarkable properties not possessed by ordinary nitrogen. It easily forms nitrides in contact with elements, and certain atoms flash out to give their characteristic lines when introduced into the active mass.

The first satisfactory theory of active nitrogen was given by Prof. M. N. Saha and Dr. N. K. Sur who tried to account for the observed facts by assuming that active nitrogen is loaded by the discharge to a high energy content which is delivered to a second substance by the process known as "Collision of the Second Type." The energy thus communicated gives rise to the reactions noted. The theory had amazing adventures during the last ten years in the hands of American and German workers who, in trying to improve the details, introduced further hypotheses. It appears, however, in view of the recent work by Herzberg who proved that the heat of dissociation of nitrogen is only 7.34 volts, that these latter phases of the theory must be given up.

Recently Lord Rayleigh II has performed a series of remarkable investigations on the after glow of nitrogen. By washing the surface of the containing glass vessel with sulphuric and metaphosphoric acid, he finds that the luminosity persists for over *five hours*. The highest values obtained in previous experiments were only a few minutes. Lord Rayleigh shows that in the earlier experiments, the glow was

destroyed by the action of the untreated surface. Such a long life is absolutely unthought of, and realizes the physicists' dream of 'bottling up the light.' It will be interesting to see how this extraordinary long life can be explained by current theories. Lord Rayleigh further proves that a study of the decay of luminosity shows that the process is bimolecular, *i.e.* light is emitted not spontaneously by the active molecule, but when two active molecules *collide*. Truly had Berthelot described Nitrogen as "Stupor Elementi"—the wonder element.

L. S. Mathur.

The Utilization of Cacao Shell

Knapp and Coward found recently that cacao shell, which is a by-product of chocolate manufacture, was quite exceptional among vegetable products in being fairly rich in vitamin D, its potency being one-fourth that of an average sample of cod-liver oil. Investigating the nutritional aspect of this question, S. K. Kar and K. M. Henry (*Biochem. J.*, 29, 2051, 1935, have made the observation that the feeding of 2 lbs. of this shell daily to cows raises the vitamin D content of the butter obtained very considerably. In this manner butter-fat obtained from stall-fed cows in winter has been raised to the summer level in vitamin D-value. The research points to an important utilization of cacao shell.

B. C. G.

University and Academy News

Asiatic Society of Bengal

Medical Section

A Meeting of the Medical Section of the Asiatic Society of Bengal was held in the Society's Room, on Monday, *the 18th November,* 1935, *at 6 p.m.*

The following papers were read:

1. S. L. Hora. *-Recent Indian Cases of live Fishes impacted in the Food and air Passages of men.*

Summary

In a series of three articles, Dr. E. W. Gudger has brought together 38 recorded cases of live fishes in the human food and air passages. These records date from 1567 to 1933 and show that the phenomenon occurred in several countries. Of the 38 cases discussed by Gudger, 12 are known to have occurred in India and Burma. Through the kind help of Major General D. P. Goil, 19 more cases have been collected from all over India and Burma 1 from the Bombay Presidency, 6 from the Madras Presidency, 3 from Bihar and Orissa, 1 from Bengal, 5 from Assam, and 3 from Burma. Of the 31 cases, 17 were due to *Koi* (*Anabas testudineus*), 4 to *Kholisha* (*Colisa fasciata*), and 1 each to *Mastacembelus, Therapon,* and *Cyanoglossus.* The types of fish responsible for the remaining 7 accidents are not known. As regards the location of the impacted fishes, in all Indian cases discussed by Gudger, the fish were found in the pharynx. Of the 19 cases now recorded, in 13 cases the fish was lodged in the food passage and in 6 cases in the air passage. The reports regarding the nature of treatment and the condition of patient are given.

The various types of fish enumerated above were exhibited.

2. B. G. Mallaya. *-Surgical Aspect of live Fishes impacted in the human Food and air Passages.*

Summary

The treatment in cases of this type is that of a foreign body lodged in the food and air passages. These cases are surgical emergencies and hardly any time is available to prepare for an operation on an elaborate scale, let alone sending for a surgeon or a specialist in Ear, Nose, and Throat work.

The point that requires immediate attention is whether there is respiratory embarrassment or not. In the majority of such cases there is extreme urgency as revealed by the heavy mortality in the cases collected with such care and labour by Dr. S. L. Hora. While confronted with a case of extreme urgency of this type, it is the opinion of the author that the immediate treatment should consist in doing a tracheotomy as a life sa ing measure.

The Academy of Sciences, U. P.

Special Meeting.

A special meeting of the Academy of Sciences of the United Provinces of Agra and Oudh was held on Thursday, October 31, 1935 at 4 p.m. in the Physics Lecture Theatre, Muir College Buildings, Allahabad. Prof. N. R. Dhar, President of the Academy, was in the Chair. The changes in the Memorandum of Association and the Rules and Regulations of the Academy of Sciences, U.P., as recommended by the general body of the Academy at a special meeting held on September 18, 1935, were unanimously confirmed.

Monthly Meeting

An Ordinary Monthly meeting of the Academy of Sciences of the United Provinces of Agra and Oudh was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad, on Thursday, October 31, 1935 at 4-30 p.m. Prof. N. R. Dhar, President of the Academy, was in the Chair.

The following gentlemen were elected as Members of the Academy of Sciences, U.P. :—

(1) Prof. D. M. Bose, Calcutta University, Calcutta; (2) Dr. R. C. Mazumdar, Punjab University, Lahore; (3) Mr. J. M. Sen, Inspector of Schools, Bengal Presidency; (4) Prof. Panchanan

Maheshwari, Agra University, Agra; (5) Mr. Ganesh Prasad Dube, Rajput College, Agra; (6) Rai Amarnath Agarwal, Bari Kothi, Daragunj, Allahabad; (7) Mr. Piare Mohan, Allahabad University, Allahabad; (8) Mr. Rajendra Behari Lal, Asst. Traffic Supdt., E.I.R., Allahabad; (9) Mr. Anand Mohan, Asst. Traffic Supdt., E.I.R., Allahabad; (10) Mr. L. S. Mathur, 4, City Road, Allahabad; (11) Prof. Y. Bharadwaja, Benares Hindu University, Benares; (12) Mr. B. L. Gulatee, Survey of India, Dehra Dun; (13) Mr. V. G. Oak, I.C.S., Muttra; (14) Prof D. N. Chakravarti, D.Sc., King Edward College, Amraoti; (15) Dr. S. Mukerjee, D.Sc., Calcutta School of Tropical Medicine; (16) Dr. H. Chaudhari, Botany Dept., Punjab University, Lahore; (17) Mr. P. N. Sharma, Lucknow University, Lucknow; (18) Dr. K. N. Mathur, Lucknow University, Lucknow; (19) Prof. B. N. Biswas, Rajaram College, Kolhapur; (20) Prof. M. S. Desai, M.Sc., Surat, (Bombay Presidency); (21) Dr. N. G. Shabde, D.Sc., College of Science, Nagpur; and (22) Mr. V. M. Dabadghao, M.Sc., College of Science, Nagpur.

The following papers were read and discussed :—

1. S. C. Damle : A Note on Sir Shah Muhammad Sulaiman's New theory of Relativity.
2. Prof. N. R. Dhar & S. K. Mukerjee : Use of molasses in the reclamation of alkali and Usar lands.
3. Prof N. R. Dhar & S. P. Tandon : Influence of Temperature on the fixation of nitrogen by azotobacter.
4. A. M. D'Rozario : On Two New Xiphidiocercaria from the common freshwater snail Indoplanorbis exustus (Deshayes) of the Northern India.

Mr. Damle pointed out that the degrees of accuracy of the two differential equations of motion obtained by Sir S. M. Sulaiman in Section V of Chapter I of his theory were different. In the second equation itself the term which is retained in one factor is neglected in the other i.e. in $\cos a$. When $\cos a$ is taken up to the same order of small quantities as there are in the other factor the value for the "Deflection of Light" becomes 2.03 instead of 2.32; and then Einstein's value cannot be obtained as an approximation to Sir S. M. Sulaiman's value. Further it was mentioned that the equations themselves could not be legitimately used in the case of light for they were obtained on the assumption that the velocities concerned are small compared to that of light. It was then shown that to maintain the same degree of accuracy in both the equations, the term containing the first differential coefficient of the distance from the centre should be retained in the first of the equations. To ignore this term in the first equation on the reason that the orbit is nearly circular is not valid, especially as the first as well as the second differential coefficients of this distance are retained in the second equation. It may be argued that this term may be neglected because it has different signs in the two halves of the orbit. But if this be so then there is no harm in retaining it. On the other hand the retention of this term should then improve the result. It was, however, shown that when this term is retained in the first equation and the other correction is introduced in the second the value obtained for the rotation of the perihelion of Mercury in one complete revolution is numerically one-sixth of the usually accepted value and in the opposite direction. Unless the theory is able to explain these results it cannot be of much use.

In his reply Sir S. M. Sulaiman dealt with the points raised by Mr. Damle serially. He agreed that for the sake of greater accuracy more terms should be retained in his equations of motion. The term $3/D\ dr/dt$ was neglected in his equations as the latter applied to nearly circular orbits. Even in the case of Mercury, this value should be of a small order for a complete revolution. If dr/dt is to be retained in (5.41) then the orbit would become elongated and a different value for $\sin a$ would have to be substituted. $\mathrm{Cos}\ a$ would similarly be different from unity. If, however, change in the magnitude of the force along the resultant were considered, as referred to in Chap. VIII, then (5.6) remains unaltered. The equations when applied to an elongated orbit certainly give a negative residual. But for the advance of the perihelion there is such a large uncertainty that von Gleich asserted in 1931 that the supposed advance does not exist and that "the Newtonian theory of gravitation needs no correction by Relativity." The maximum and minimum limits of the value for the deflection of light, with the correction

proposed by Mr. Damle, in fact tally better with Freundlich's value. The approximate equation can not hold for light, and a new set of equations have been obtained for light in Chapter VIII. The retention of the term $3|D \quad (dr|dt)^2$ in equation (6.61), which Mr. Damle advocates, leaves the results unaffected. An empirical law of gravitation

$$-\frac{\mu}{r^2} - \frac{3\mu h^2}{D^2} \cdot \frac{1}{r^4}$$

gives all the required results and avoids all the difficulties.

PROF. N. R. DHAR gave an account of the researches carried on by him and his collaborators in the reclamation of alkali and *Usar* lands by the application of molasses.

Prof. Dhar stated that the total area of *Usar* lands in the United Provinces alone is more than 3,000,000 acres and naturally the reclamation of such lands is a problem of great national importance. The salts which make these lands unfit for growing crops are carbonate, sulphate and chloride of sodium. Such lands are generally heavy clay soils and are very often termed as *parti* or waste lands.

Much research work has been carried on by Dr. Gedroiz of Russia, by Dr. Hilgard in the United States, by Dr. de'Sigmond in Hungary, Dr. Dymond in England and by Dr. Hissink in the Zuyder Zee area in Holland for the reclamation of alkali lands and those damaged by sea water in their respective countries. In these researches, gypsum, ammonium sulphate, powdered sulphur etc. have been used but these substances are too costly for use in India.

Molasses to the extent of 90—360 maunds per acre have been applied to some alkali lands near Allahabad, Cawnpore and other places in the United Provinces and the lands ploughed once and watered. Analysis showed that the alkalinity of these lands decreased considerably on the application of molasses and later on became appreciably acidic. The acids were oxidized in course of time. In these reclaimed lands, good crop yield has been obtained.

Prof. N. R. Dhar gave an account of researches carried on by himself and his pupil Mr. S. P. Tandon, on the influence of temperature on nitrogen fixation by Azotobacter. The professor stated that it was rather surprising that this type of nitrogen fiaxation had not been utilized very much in European and other colder countries. On the other hand the nodule bacteria have been largely utilized in agriculture for increasing the soil nitrogen in temperate climates.

The researches carried on in the Chemical Laboratories of the Allahabad University show that the best temperature for nitrogen-fixation by azotobacter is 35°C. There is no nitrogen fixation either at 0°C or 50° C on the one hand, on the other no nitrogen-fixation takes place at 60° or 70°. It is rather surprising that those bacteria can fix nitrogen even at 50°C, although the amount of fixation at 50°C is much less than at 35° C. It is well established that the other bacteria nitrifying, ammonifying etc. become inactive at 40 °or can utmost work up to 45°C, while azotobacter works appreciably at these temperatures. Various are the ways in which nature carries her decree. She has to be impartial to each and every country of the world in bestowing worldly comforts. It seems, therefore, that in tropics where all other factors are unfavourable in recuperating the soil as regards combined nitrogen nature has been kind to bestow these two agencies namely sunlight and azotobactor to meet the nitrogen requirements of two tropical soils.

Uptill now the study of this so useful a nitrogen-fixer as azotobacter was overlooked by the scientists of our country. The Chemical Department of the Allahabad University under the careful guidance of Prof. Dhar has given a long needed lead in this line of study to the scientists of India. It presents now before our scientists a fertile field for future research which, it is hoped, will result in evolving out some practical method for an useful employment of azotobacter in the agriculture of our land. Moreover Indian soils have been found to be rich in azotobacter.

As the soil temperature in temperate climates is generally 10 °C or lower, the activity of azotobacter in these countries is very little in most part of the year and that is why the farmer in a temperate climate cannot utilize the sources of azotobacter, whilst in tropical countries it can serve a very useful purpose.

Ordinary Meeting

A meeting of the Academy of Sciences, U. P. was held in the Chemistry Department, Lucknow University on Saturday, November 9, 1935 at 3 p.m. Prof. N. R. Dhar, President of the Academy was in the Chair.

Messrs. Chandra Mohan Chak, M.Sc. (Cantab), and P. N. Tandon, I.C.S. were elected members.

The following papers were read and discussed :

1. S. Pradhan : The Genitalia and their Role in copulation in Epilachna indica (*Coccinellidae Coleoptera*) with a discussion on the Morphology of the Genitalia in the family.
2. H. Trivedi : The absorption spectrum of hydrogenbromide molecule and its upper unstable state.
3. V. V. Narlikar and D. N. Moghe : A Note on a general line element.
4. D. N. Moghe and R. V. Sastry : The field of a Non-static Spherical condensation.
5. Satyendra Ray : The first universal principle of Sulaiman.
6. Satyendra Ray : On two mutually contradictory interpretations of Einstein's line-element by Sulaiman.
7. K. L. Gupta : On the convergence and the summability of the conjugate Series of the Derived Fourier Series.
8. S. M. Sane and A. B. Sen : On some Toluen Sulphonyl Esters of Phenols.
9. M. Raman Nayar : Variation of physical properties with change in concentration of Iodic acid solution.
10. Umakant Shukla : Necessary and sufficient condition for the equality of

$$\frac{d}{dy}\int_a^b f(x, y)\,dx \text{ and }$$

$$\int^b \left[\frac{d}{dy}\left\{ f(x, y) \right\}\right]dx$$

11. B. M. Gupta : On the Relationship between the soluble fatty acids and the potash equivalent of acids giving barium salts.
12. A. C. Chatterji : Influence of Lyophillic colloids on the wettability of Naphthalin.

Mr. Pradhan described the structure and disposition and the mode of working of the muscles of the male and female genitalia of Epilachna indica, and their relative disposition during copulation. He discussed the process of oviposition and also the morphology of the male genitalia, and suggested new interpretations.

Mr. Trivedi, whose paper aroused some interest, showed that his experiments were a further test of his theory of continuous absorption of a diatomic molecule and that he was enabled to find out the nature of the repulsive state of the molecule by its help.

Prof. Satyendra Ray, in his first paper, said that Sulaiman has given new law for the relative velocity of two bodies moving in the same straight line. As Newton's laws are accepted in the proof it is logically impossible to get any result different from the Newtonian expression. The fallacy in Sulaiman's argument lies in his confusion of initial and final distances between the two moving bodies in his arithmetical investigation.

In the other paper Prof. Ray said that Sulaiman proceeds with a corpuscular theory of light and then uses the formula applied by him to the problem of perihelion motion of Mercury. In doing this he makes the elementary portion of the corpuscle's orbit identical with the famous " Line-element " of Einstein. Contradictory results, however, tumbled out from Einstein's theory at Sulaiman's own showing which Sulaiman has failed to exploit. He later on gave another physical interpretation in which " ds " is not the element of the planetary orbit perpendicular to the line of vision, but " projection of the distance travelled by light " on the radial distance of the planet from the centre of force.

Dr. A. C. Chatterji said that wettability of naphthaline by gelatine, agar-agar, casien, wheat-starch and silicic acid has been investigated before. It has been found that the lyophillic colloids can be

arranged according to the descending order of their wetting power as follows.

gelatine >, casien >, starch >, agar-agar >, silicic acid. It is interesting to compare this series with the series obtained by arranging them according to descending order of their "gold number" which measures their protective effect. The series is gelatine > Na casienate > potato starch > silicic acid. It appears that the power to wet and the protective effect of lyophillic colloids bear a very close relation with each other, both being due to absorption of the colloid by the respective particles.

The Institution of Chemists (India)

At an ordinary meeting of the Institution of Chemists (India) held on Monday, the 11th November, 1935 in the Chemistry Lecture Theatre of the University College of Science, Calcutta, a paper entitled "The Problem of the utilization of molasses" communicated by Prof. N. R. Dhar, D.Sc., F.I.C. Head of the Chemistry Department, Allahabad University, was read by Dr. S. G. Choudhury of the Science College. Dr. H. K. Sen, Professor of Applied Chemistry, Science College, Calcutta, the President of the Institution, was in the chair.

Prof. Dhar after referring to the comparatively poor yield per acre of sugar cane in India, was of the opinion that the future of sugar industry in India depended to a great extent on the proper utilization of the molasses which is the chief by-product of the industry. The present day utilization of molasses in many countries, as for instance in the production of power alcohol, acetic acid, glycerine, potash, cattle food, fuel etc. was dealt with in the paper. But in his opinion these cannot sufficiently absorb all the 500,000 tons of molasses turned out annually by the various sugar factories in India. Its only hope lay in using it to enrich the soil, in as much as its sugar, potash, and nitrogenous matter contents make it a very useful fertilizer, and its use as a manure, especially in India, where the soil suffers from a nitrogen deficiency, was mainly stressed in this paper. Experiments conducted by Prof. Dhar and his collaborators in the chemical laboratories of the University of Allahabad which were described in detail in the paper showed conclusively that the amount of combined nitrogen, the most important substance necessary for plant growth, is considerably increased when molasses are added to the soil and the soil ploughed properly. The fixation of nitrogen *i.e.* the addition of ammonia to the soil can take place in the complete absence of bacteria provided the carbohydrates are oxidized through the agency of sunlight and chemical catalysts. The potash, phosphates, and combined nitrogen of molasses no doubt have their own value as fertilizers but the chief manurial property of molasses is due to its sugars, which, by undergoing oxidation, supply the necessary energy required for nitrogen fixation by the soil, causing a crop increment of at least 36%.

The failure of certain previous workers of Java and other places in utilizing molasses in this way was explained by the author as mainly due to insufficient aeration of the soil and other factors; and then he gave systematic instructions as to how to use molasses as manure for getting beneficient results. He recommends 90-270 maunds of molasses per acre to be applied to the soil after diluting with water and three months before plantation, with frequent ploughing. There was a lively discussion on the subject. Mr. Alcock of Messrs Alcock & Co. raised the question of the difficulty of transport of molasses to the fields from the factory, and was of the opinion that burning the molasses and using the ash obtained as a manure is far more economical. He then gave a description of a simple type of furnace designed by them to burn the molasses for this purpose. Mr. K.B.Sen, F.I.C., of Messrs Bird & Co., pointed out some defects in the use of potash ashes as fertilizers, and gave some of his own experiences as regards the drawbacks in the economic products. Prof. H. K. Sen was of the opinion that the problem of the utilization of molasses' for the production of power alcohol was rather underrated by Prof. Dhar.

Some points were raised whether the cost of molasses would be compensated by the increase in yield, say, in sugar cane cultivation, and by calculation it was found to be really profitable. Messrs D. S. Naidu and Atma Ram of the Govt. Test House, Alipore, had a discussion as regards conditions of nitrification and also of denitrification of the soil in the use of molasses as a fertilizer.

The President, after a discussion at length of the

pros and cons of utilizing molasses either as a manure or in the production of power alcohol, in which Mr. B. Pal (Inspector of Explosives) took part, summed up the proceedings as below:

There seemed to be a general agreement that the question of the transport of molasses could be greatly simplified if the manufacturers had their own plantation situated at reasonable distances from the operating plants. The export of molasses into Great Britain, as is being now considered, even if it were realized, could only be a temporary measure, and as such for the solid foundation of the Indian Sugar industry, the utilization of molasses must be conceived of not from one point of view, but from the various methods of utilization raised in the discussion. These methods of utilization may vary from locality to locality, but there is no doubt that a larger outturn of the cane per acre in the region of 40 tons as against 20 at present obtained is at the bottom of a sound sugar industry. The combination of power alcohol with petrol was regarded as a well rationalized system in which the interests of all the manufacturing parties would be safeguarded within reasonable limits. The President specially emphasized the need for a temporary restriction on petrol output for a period of eight to ten years, to allow the annual increased automotive demand of the country to be met by alcohol, the maximum annual output of which would rarely exceed 30 million gallons, when to-day petrol consumption is in the region of 80 million gallons. Dr. Dhar's paper has certainly given a distinct turn to the molasses problem which requires now to be more fully tested by field experiments.

The meeting closed with a remark from the chair that the Institution of Chemists (India), before which of late so many papers bearing on the various aspects of sugar industry have been read and discussed, has really done a great service to this industry in this country, judging from the enquiries it has been receiving from the outside public on these matters.

Indian Science News Association

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Letters to the Editor

The Effect of dietary Composition on the Urinary Excretion of Ascorbic acid (Vitamin C) by the rat.

In a study of the mechanism involved in the biological synthesis of Vitamin C, we found by using the titrimetric technique with 2.6 dichlorophenol that mannose could act as a precursor of the vitamin in its synthesis by the rat. In connection with this work it was considered desirable to know whether the excretion of ascorbic acid by the rat would be influenced by the metabolism of the major food-constituents – a possibility indicated by some recent experiments of Hopkins[1]. The urinary output of ascorbic acid was, therefore, investigated titrimetrically with rats fed on the following artificial diets, which differed from one another in their protein, fat and carbohydrate contents.

	Diet X	Diet Y	Diet Z	Diet A	Diet B
Casein	10	25	40	20	20 parts
Cassava Starch	80	65	50	70	35 „
Salt-mixture (McCollum)	5	5	5	5	5 „
Yeast	5	5	5	5	5 „
Cod-liver Oil	1	1	1	1	1 „
Lard	—	—	-		35 „

A group of three adult rats was successively fed with diets X, Y and Z (in which there is an increasing ratio of protein to carbohydrate) for periods of 10 days, the urine collected for the first 4 days of each period being rejected. The average volumes of urine excreted during 24 hours on the three diets were respectively 25 c.c., 25 c.c. and 32 c.c. and the corresponding total ascorbic acid outputs 0.38 mg., 0.39 mg. and 0.57 mg.

Another group of three adult rats was fed successively on diets A and B (which are respectvely non-fat and fat diets) in a similar way. The average volumes of urine excreted were 24 c.c. and 23 c c. respectively and the corresponding values of ascorbic acid output were 0·43 mg. and 0.55 mg.

It would thus appear that the excretion of urinary ascorbic acid by the rat tends to be definitely stimulated by raising the protein-carbohydrate and fat-carbohydrate ratios of the diet. The problem is being further investigated to find if the reducing substances in the urine consists solely of ascorbic acid and to obtain further results for statistical analysis.

Indian Institute for Medical Research, Calcutta.
and
Bengal Chemical & Pharmaceutical Works Ld., Calcutta.

B. C. Guha
A. R. Ghosh

16.11 1935

1. *Chemistry and Industry*, **53**, 874. 1934.

Vitamin B_2

We pointed out elsewhere [1] that preparation of renoflavin had their growth-promoting effect enhanced, as observed on growing rats subsisting on a vitamin B_2-deficient diet, by the simultaneous administration of an alkali-autoclaved preparation of an ox-kindney extract left after adsorption with fuller's earth. The animals received the usual basal diet supplemented by a preparation of vitamins B_1 and B_4, obtained from yeast according to Peters' method, which constituted the sole source of "Vitamin B"-complex. These experiments seemed to suggest that the total growth-promoting effect of vitamin B_2 was to be ascribed to the flavin and a more heat and alkali stable factor, as the flavins are known to be relatively unstable to alkali particularly at a high temperature.

We have attempted to investigate this problem in another aspect by comparing the vitamin B_2-activity of a few natural food-stuffs assayed by the usual biological technique with their flavin-content as determined chemically by the method of Kuhn, Wagner-Jauregg and Kaltschmitt[2]. In employing this chemical method we have used a Lovibond tinto-meter of the B.D.H. pattern in the absence of a stufo-photometer for the tintometric estimation. Investigating the pulses, ***Lens esculenta, Pisum arvense, Cajanus indicus, Cicer arietinum, Lathyrus sativus*** and ***Phaseolus mungo***, we have found no parallelism between the flavin content and biological activity. The limits of error in such experiments are, however, fairly large and no strict conclusion is, therefore, warranted.

The same problem has also been investigated with reference to cow's milk. The growth-promoting effect of pure lactoflavin (two samples kindly provided by Prof. R. Kuhn. and Prof. P. Karrer were used) was first determined.

The lactoflavin was then supplemented by an alkali-autoclaved fuller's earth filtrate of milk, which was presumably free from flavin, and the growth-promoting effect was found to be enhanced. It was found, further, that 2 c.c. of whole milk produced considerably greater effect than the administration of 0.002 m.g. lactoflavin, which represented the flavin content of 2 c.c. of milk. These results would appear to suggest that milk contains some factor besides lactoflavin, which increases the growth-promoting effect of the flavin.

It may be stated incidentally that in course of some physiological studies carried out by one of us (B. C. G.) with Mr. N. Das we have found that lactoflavin restores the red blood cell count in rats, which was found to fall in vitamin B_2-deficiency by Guha and Mapson[3] in 1921.

Details will be published elsewhere.

Indian Institute for Medical Research, Calcutta, and Bengal Chemical & Pharmaceutical Works, Ld., Calcutta.
16.11.35

B. C. Guha
H. G. Biswas.

1. Guha and Biswas, *Current Science, 3,* 1935;
Guha and Biswas, *Ber. d. duetsch. chem. Gesell., 68,* 427, 1935;
Guha, *Nature, 185,* 395, 1935
2. Kuhn, Wagner-Jauregg and Kaltschmitt, *Ber. d. deutsch. chem. Gesell, 67,* 1152, 1934 ;
3 Guha and Mapson, *Biochem J. 25,* 1664, 1931

Glutathione and Milk Dehydrogenase

Glutathione in its reduced form has been found to accelerate the oxidation of xanthin as well as of acetaldehyde and salicyaldehyde by milk dehydrogenase. The following typical results are appended, the experiments being carried out at p_H 8 with phosphate buffer.

Similar results were obtained with acetaldehyde. The enzyme material was the caseinogen preparation of Dixon & Thurlow[1]. The minute traces of hydrogen peroxide formed in these oxidations would be unstable at p_H 8 and, therefore, the removal of the inhibiting effect of hydrogen peroxide by its interaction with reduced glutathione does not account for the observed acceleration in oxidation. The explanation is probably to be sought in the participation of glutathione as an oxidation reduction system in oxidations by milk dehydrogenase. The hypothesis that in these oxidations molecular oxygen acts as the direct acceptor of activated hydrogen might, therefore, require modification.

We are also investigating the effect of ascorbic acid on these oxidations.

Bio-chemical Section,
Chemical Laboratories
University of Dacca
5. 11. 35

K. P. Basu.
S. P. Mukherjee.

1. *Biochem. Jour. 18,* 971, 1924

mm³ of O_2 absorbed

Time in mins	Xanthin M/1200 & enzyme	Glutathione M/1200 & enzyme	Xanthin M/1200 Glutathione M/1200 & enzyme
15	51	10	71
30	60	13	91
60	63	14	1C6
	Salicyaldehyde M/400 & enzyme	Glutathione M/1200 & enzyme	Salicyaldehyde M/400 Glutathione M/1200 & enzyme
15	25	9	44
30	37	12	70
60	40	13	84

"Artostenone" a diketo compound related to sterols isolated from the Indian summer fruit "Artocarpus Integrifolia" (Jack fruit)

Working up the unsaponifiable matter of the ether-soluble fraction of the juice collected from the freshly cut ripe fruit, it has been possible to isolate a fine crystalline substance melting at 109°C. It shows some of the colour reactions of sterols and is highly soluble in most of the organic solvents.

The micro combustion data as well as the crystallographic investigation by means of X-ray suggests its molecular formula to be $C_{28}H_{44}O_2$.

The substance contains no hydroxyl, aldehyde or acid group. The presence of two keto-groups has been definitely proved from the formation of a di-oxime (m.p. 175°C; N-6%). Hence the name "Artostenone" has been proposed for the substance.

Artostenone is dextro-rotatory, its specific rotation being $[\alpha]_D^{30°}$ =19.9° and 23.4° in alcohol and chloroform respectively.

The molecular weight of artostenone has been found to be 107.2 by cryoscopic method with benzene as solvent, and crystallographic data by means of X-ray give the value 118 as the molecular weight. Its density is 1.08.

The substance forms a tetrabromo compound (Br. 43.4%) having a sharp melting point of 160°C. Two bromine atoms enter the compound by substitution, the remaining two saturating the ethylene linkage.

Results with bromination and reaction with IBr show the presence of only one double bond in artostenone. The low specific rotation also supports the observation.

Details of the experimental procedures and results will shortly be published elsewhere. Investigations to gain some insight into the constitution of artostenone are in progress. Work has also been undertaken to see whether the substance or any of its derivatives possesses any physiological activity.

Biochemical Section,
Chemical Laboratories,
University of Dacca.
5.11.35.

Madhab Chandra Nath.

A New Route to Spiro Compounds Synthesis of Spirocyclodecane

 (1)

A new synthesis of Spirocyclodecane has been achieved according to the following lines. Cyclohexanone cyanohydrin is allowed to react with the sodium salt of ethyl cyanoacetate and the sodium salt of ethyl 1 - cyanocyclohexane - 1 - α - cyanoacetate thus obtained is allowed to react with ethyl β - chloropropionate to yield diethyl 1 - cyanocyclohexane - 1 - α cyanoglutarate (Bp. 220°-25°/8mm). On hydrolysis the above ester yields 1 - carboxy cyclohexane - 1 - α - glutaric acid (m.p. 165°C). The ester (Bp. 163°/4mm) when subjected to the action of sodium in benzene yields diethyl cyclohexane spirocyclopentane - 2 - one - 3 : 5 - dicarboxylate (Bp. 178°/4mm). It is hydrolysed by means of sulphuric acid to yield cyclohexane spirocyclopentane - 2 - one 5 - carboxylic acid (M.P. 102°C). Spirocyclodecane (1) is obtained by the Clemmensen reduction and subsequent decarboxylation of cyclohexane spirocyclopentane - 2 - one - 5 - carboxylic acid.

Further work on the synthesis of other spiro compounds along similar lines (by taking different cyclic ketones such as methyl cyclohexanones, cyclopentanone, methyl cyclopentanones, etc. on the one hand and different halogenated esters on the other) is in progress.

The details of the above work will be published in the *Journal of the Indian Chemical Society*.

My sincere thanks are due to Professor Dr. P. C. Mitter for much encouragement and advice during the course of this work.

Sir R. B. Ghosh Laboratories,
University College of Science
15.11.35

Nripendranath Chatterji.

Certain derivatives of Thiocamphor and Thioborneol. Reactivity of methylene group due to the influence of Thiocarbonyl group.

In a recent communication to the *Journal of the Indian Chemical Society*, the author described the preparation of *iso*nitrosothiocamphor (B) by the action of *iso*amyl nitrite on thiocamphor in presence of sodamide.[1] The preparation of this compound suggests that the methylene group adjacent to the CS group in thiocamphor (A) is reactive, whereby the formation of the above compound has been possible.

$$C_8H_{14}<\begin{matrix}CH_2\\|\\CS\end{matrix} \quad \ldots\ldots \quad C_8H_{14}<\begin{matrix}C{:}NOH\\|\\CS\end{matrix}$$
$$\text{(A)} \qquad\qquad\qquad \text{(B)}$$

It was therefore thought desirable to study the action of benzaldehyde on the sodium derivative of thiocamphor and it has been possible to isolate a benzylidene derivative of thiocamphor (C),

$$C_8H_{14}<\begin{matrix}C{:}CHC_6H_5\\|\\CS\end{matrix}$$
$$\text{(C)}$$

by allowing benzaldehyde to react at 0°, with the sodium salt of thiocamphor which itself is prepared by the interaction of requisite quantity of molecular sodium and thiocamphor in benzene. After removal of benzene and unchanged benzaldehyde, the residue crystallizes out from alcohol in the form of needleshaped crystals, m p. 9?°.

Benzylidene-thiocmaphor reacts with hydroxylamine hydrochloride in presence of sodium acetate, whereby benzylidene-thiocamphor oxime is formed with evolution of H_2S, m.p. 197°. (Cf. benzylidene-camphor oxime, m.p. 197°). The above reaction definitely establishes the influence of thiocarbonyl group on an adjacent methylene group and thereby establishes the much expected analogy between a carbonyl and a thiocarbonyl group, so far as the reactive methylene group is concerned.

The first attempt in this line was due to Mitra [3] who instead of obtaining benzylidene derivatives of β-thioketonic esters by the action of benzaldehyde on β-thioketonic esters obtained polymerized thiobenzaldehyde—(Ph. CHS), and the benzylidene derivative of corresponding β-ketonic esters — (Et$_2$benzylidene diacetoacetate in the case of Et-thioacetoacetate).

Sodium salt of thiocamphor when benzoylated in cold, forms monobenzoyl-thiocamphor, a red liquid, b.p. 186°-187°/10 m.m., having a camphoric smell. The compound can be represented by either of the formulae (E) or (F)

$$C_8H_{14}<\begin{matrix} CH.\,CO\,C_6H_5 \\ | \\ CS \end{matrix} \qquad \text{or} \qquad C_8H_{14}<\begin{matrix} CH \\ \| \\ CS.\,CO.\,C_6H_5 \end{matrix}$$

(E) (F)

The constitution of this compound has not yet been settled and experiments are now in progress. In either case, the formation of the componnd represents the labile nature of one of the hydrogen atoms attached to the CH_2 group adjacent to the CS group.

Thioborneol has also been prepared by the author in the pure state by reduction of thiocamphor by means of zinc and acetic acid[3]. But as the yield of this material was not satisfactory, thiocamphor has subsequently been reduced by means of aluminium amalgam in moist ethereal medium. The product obtained by either of these methods has been purified by the formation of a lead salt followed by its decomposition with H_2S and subsequent extraction with ether. In the second case the yield is nearly 60%.

The importance of the ethers and esters of borneol is well-known. Hence it was supposed that the corresponding thio-derivatives might be interesting. The following derivatives of thioborneol have been prepared by taking advantage of the reactivity of the thiolic H* atom of thioborneol (G). (1) Methyl-Bornylthio ether, b.p. 95°/25 m.m., (2) Ethyl-Bornyl-thio ether b.p. 95°/5 m.m., (3) Isoamyl-Bornyl-thio ether, b.p. 133/6 m.m., (4) Acetylated thioborneol, b.p. 85°/25m.m., (5) Benzoylated thioborneol, b.p. 180°/6m.m. etc.

$$C_8H_{14}<\begin{matrix} CH_2 \\ | \\ CH.\,SH^* \end{matrix}$$

(G)

These compounds are not bad smelling substances like other sulphides; they have rather a characteristic smell resembling that of turpentine oil.

My thanks are due to Sir P. C. Ray for his kind encouragements and also for kindly placing the resources of his laboratory under my disposal.

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6.11.35.

D. C. Sen.

1. SCIENCE AND CULTURE, *1*, 158, 1935.
2. *Jour. Ind. Chem. Soc.*, *9*, 633, 1932.
3. *Ber.*, *36*, 863; *39*, 3503.

On the Evaluation of the Probability Integral of the D²-Statistics.

The exact distribution of the D^2-statistics, constructed by P. C. Mahalanobis[1] in an attempt to estimate the divergence between two populations, was found by one of the authors in the form which after the substitutions

$$\lambda^2 = \tfrac{1}{2}\,\bar{n}\,P\,\Delta^2, \qquad L^2 = \tfrac{1}{2}\,\bar{n}\,P\,D_1^2$$

can be written as

$$F_p(L,\lambda)\;dL = \left(\frac{L}{\lambda}\right)^{\frac{P}{2}-1} L\, e^{-\frac{1}{2}(L^2+\lambda^2)} \times I_{\frac{p}{2}-1}(L\lambda)\,dL$$

where D_1^2 is the uncorrected sample value, and Δ^2 the population of D^2, and I is the Bessel function of pure imaginary argument.

In a previous letter, one of us invited the attention of mathematicians to the problem of the numerical evaluation of the incomplete integral

$$\Phi_p(L,\lambda) = \int_0^L F_p(L,\lambda)\,dL$$

which till then had baffled our attempts to tackle it [2]. Since then we have however overcome the difficulty in the following manner.

It is proved that

$$\Phi_p(L,\lambda) = \Phi_{p-2}(L,\lambda) - f_{p-2}(L,\lambda)$$

where $f_{p-2}(L,\lambda) = \left(\frac{L}{\lambda}\right)^{\frac{P}{2}-1} e^{-\frac{1}{2}(L^2+\lambda^2)} \times I_{\frac{p}{2}-1}(L\lambda)$

The function f obeys the recurrence formula

$$f_p\,(L, \lambda) = -\frac{P-2}{\lambda^2}\,f_{p-2}\,(L, \lambda) + \frac{L^2}{\lambda^2}\,f_{p-4}(L, \lambda)$$

This enables us to make $\Phi_p(L, \lambda)$ depend upon $\Phi_2(L, \lambda)$ or $\Phi_1(L, \lambda)$ according as P is even or odd. We show

$$\Phi_1(L, \lambda) = \frac{1}{\sqrt{2\pi}} \int_{\lambda-L}^{\lambda+L} e^{-\frac{1}{2}t^2}\,dt$$

which can be found from the tables of the probability integral. Also $\Phi_2(L, \lambda)$ is obtained in the form of the following convergent series.

$$\Phi_2(L, \lambda) = 1 - e^{-x} \sum_{n=0}^{\infty} \frac{x^n}{n!} \left\{ 1 - e^{-\xi} \sum_{m=0}^{n-1} \frac{\xi^m}{m!} \right\}$$

where $x = \frac{1}{2}L^2$, $\xi = \frac{1}{2}\lambda^2$.

The actual numerical computation is proceeding in the Statistical Laboratory, Presidency College, Calcutta, and will be published in *Sankhya :* The Indian Journal of Statistics.

Statistical Laboratory,
Presidency College, Calcutta,
24.9.35.

Raj Chandra Bose.
Samarendranath Roy.

1. *Journal of the Asiatic Society of Bengal* (1930).
2. SCIENCE AND CULTURE, *1*, 205, 1935.

On the Absorption Spectra and the Ground State of the Ce IV Ion

In recent years there has been some controversy regarding the ground state of the CeIV ion. It has been held by spectroscopists that the ground state is rather a *5d* state than a *4f* state, but this view is entirely incompatible with the following assignment of electrons for the CeIV ion given by Hund, *viz.*,

4f	5s	5p	5d	6s
1	2	6	0	0

which predicts that the ground state is a 4^2F term, and this view is well supported by the magnetic data for crystals and solutions of cerous salts *viz.*, the agreement of their magnetic moment with Hund's calculated value, and the close conformity of the temperature variation of their susceptibility with Curie's law.

The spectroscopic evidence is an extrapolation from the spectra of CsI and BaII. By plotting the term values on a Mosley diagram Gibbs and White[1] conclude that in the sixth period the 4^2F line (corresponding to an electron in the *4f* shell) will eventually cross the 5^2D line (corresponding to an electron in the *5d* shell) even though in going from CsI to BaII they diverge from one another. If the term values of $4\,^2F_{\frac{5}{2},\frac{7}{2}}$ levels given by Paschen and Goetz are correct for BaII then we should expect that these F and D lines would not cross before CeIV is reached and that therefore the first electron bound to the stripped atom of Ce is a *5d* electron. On a closer examination however, it would appear that the conclusions arrived at from such an extrapolation are not valid in the case of CeIV ion. From a comparison of the electronic structures of CsI-like stripped atoms, *viz*, CsI, BaII, LaIII, and CeIV, it is evident that the *4f* orbit is entirely of a different nature in Ce, as it is situated in the interior rather than exterior of the atom, and an extrapolation to compare the states located in different potential valleys cannot be valid.

Gibbs and White[1] and later Badami[2] have investigated the spark spectra of Ce, and a doublet with wavelengths 2778 A° and 2456 A° has been attributed by them to the transitions $6^2S_{\frac{1}{2}} - 6\,^2P_{\frac{1}{2},\frac{3}{2}}$ of the CeIV ion as according to them the observed and calculated values of the separation seem to agree. But here also their calculations are invalidated owing to the fact that the value of the screening constant used in their calculations (which is obtained from X-ray data, *viz.*, $\sigma = 34$) is for *4f* electrons and not *6s* electrons.

Recent investigations on the absorption spectra of the CeIV ion by Bose and Datta[3], Freed[4], and Roberts and Wallace[5] have led to the discovery of several absorption bands in the ultra-violet region between 3000A° and 2100A°. In a preliminary note Bose and the present writer[3] suggested that the bands at 2960A° and 2550A° are due to $4^2F_{\frac{5}{2}} - 5\,^2D_{\frac{3}{2},\frac{5}{2}}$ transitions and showed that the relative intensities of the bands may be explained if these bands arise from the above transitions. Freed[4] has also come to similar conclusions regarding the origin of these two absorption bands. Further evidence regarding the ground state of the CeIV ion is obtained from the recent measurements of the magnetic rotatory dispersion of the cerous salt solutions by Roberts, Wallace and Pierce[6] who definitely conclude that "their results throughout the wavelength range 5780 - 3341A° agree with the values calculated by taking into account two absorption bands of wavelength 2960A° and 2540A° ($4^2F_{\frac{5}{2}} - 5\,^2D_{\frac{3}{2},\frac{5}{2}}$) as given by Bose and Datta, so that the ground state is $4^2F_{\frac{5}{2}}$ (Hund) and not $5^2D_{\frac{3}{2}}$ (Gibbs and White)."

As for the other absorption bands in the farther ultra-violet region, Bose and the present writer assigned transitions $5^2D - 6^2P$, which correspond to certain emission assignments given by Badami, but stand in contradiction to Freed's interpretation who explained the origin of all the absorption bands as due to $4^2F - 5^2D$ transitions, the 5^2D state being split up into several levels by the inhomogeneous crystalline electric fields as postulated by Bethe.

To decide between the two interpretations, the absorption spectra of cerous salt solutions have been further investigated by M. Deb and the present writer with a Hilsch double monochromator and a photoelectric cell, to test whether all the absorption bands are due to transitions from the ground state and if there are further fine structures of the bands, and also to estimate the intensities of these absorption bands. The results obtained indicate that all the absorption bands arise from transitions from the ground state and the intensities of the bands except the one at 2960A° which is rather weak are fairly large and of the same order of magnitude. The results seem to support Freed's interpretation about the origin of these bands as due to transitions $4\,^2F_{\frac{5}{2}} - 5\,^2D_{\frac{3}{2},\frac{5}{2}}$, the $5\,^2D$ state being further decomposed into several levels by the inhomogeneous crystalline field. The details will be published elsewhere.

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S. Datta.
6. 11. 35.

1. *Phys. Rev.* **33**, 157, 1929.
2. *Proc. Phys. Soc.* **43**, 53, 1931.
3. *Nature.* **128**, 270, 1931 ; *Zeits. f. Phys.* **80**, 376, 1933.
4. *Phys. Rev.* **38**, 2123, 1931.
5. *Nature* **130**, 890, 1932.
6 *Phil. Mag.* **17**, 934, 1934.

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The Indian Institute of Science, Bangalore

It is reported in the press that the Government of India has been pleased to appoint Sir J. C. Irvine, K T., F. R. S., Principal and Vice-Chancellor of the University of St. Andrews, as chairman of the Quinquennial Reviewing Committee of the Indian Institute of Science, Bangalore. The other two members are Prof. S. S. Bhatnagar, Director of Chemical Laboratories, University of Punjab, and Dr. A. H. Mackenzie, Vice-Chancellor of the Osmania University, Hyderabad, and late Director of Public Instruction, the United Provinces of Agra and Oudh. The constitution of the Committee will give general satisfaction to the public. We would like to take this opportunity to acquaint our readers with a brief history of its foundation and the scope of activities of the Institute.

As is well known, the Institute owes its foundation mainly to the magnificent charities of the great Indian pioneer industrialist and philanthropist, Mr. J. N. Tata. The circumstances leading to its foundation are described in detail in his biography by F. R. Harris (Oxford University Press, 1925).

[The Viceroy has appointed a Committee consisting of Sir James Irvine, Dr. A. H. Mackenzie, Dr. S. S. Bhatnagar, with Mr. F. F. O. Edmonds as Secretary, to review the working of the Institute of Sciences Bangalore, with special reference to the purpose for which it was founded, and if any changes are considered desirable in the organization or activities of the Institute for better achievement of these purposes, to make recommendations accordingly, but with due regard to the Institute's actnal or reasonable augmentable financial resources. The Committee will meet at Bangalore in February. —*A. P.*]

The first Ideas of J. N. Tata

It appears that the late Mr. Tata conceived the idea of giving a big endowment for the promotion of scientific and industrial research as early as 1889. But in India things move slowly and it took more than twenty years for his plans to materialize. A perusal of the relevant two chapters of Tata's biography shows that for a long time he was quite undecided about the location and the scope of activities of his projected Institute. He was a busy man whose time was mostly occupied with many new industrial schemes, which afterwards culminated in the foundation of the Tata Iron and Steel Works at Jamshedpur and the three Tata Hydro-electric Companies on the Bombay side. His preoccupation with business and the large number of persons whose opinions were sought in this matter seem to be mainly responsible for the uncertainty that prevailed in defining the scope of activities of the Institute. It might be of interest to mention here that when the great American philanthropist, Andrew Carnegie, decided to give away his whole fortune in charities, he thought it best to retire altogether from business,

and devote his whole time in devising the best methods of administration for his charities. Carnegie mentions in his autobiography that he took this decision because experience had told him that it was easier to accumulate millions than to devise a rational scheme of expenditure which would bring the contemplated results. Unfortunately, Tata had not that leisure and probably could not find enough time to acquaint himself with the educational conditions of India and her future needs, and consequently his plans changed from time to time. In addition, as already mentioned, he also appears to have suffered from a multitude of counsellors.

It is needless to dwell here on the long controversies regarding the location and scope of the Institute. For a long time the choice lay among Calcutta, Bombay, and Bangalore. The main circumstance which led to its foundation at Bangalore appears to be an invitation by the late Sir Sheshadri Iyer, the then Dewan of Mysore, offering a sum of five lakhs of rupees towards the cost of the building of the Institute, 300 acres of rent-free land in Bangalore, and a recurring grant of one lakh of rupees for the maintenance of the Institute. This last offer was reduced to Rs. 50,000 after the death of the Dewan. The Government of India contributed a sum of two and a half lakhs towards the capital expenditure. The recurring expenditure at present is made up approximately as follows :—

Income from Tata Charities, an amount which varies from 3 to 4 lakhs ; Government of India : 1½ lakhs ; and the Mysore Government grant : Rs. 30,000* ; and varying amounts of smaller grants from other Indian provinces and states.

Sir William Ramsay's Ideas

On the scientific side advice was sought from the famous chemist, Sir William Ramsay, in 1900, who confirmed the selection of Bangalore, because "the State of Mysore is rich in minerals ; it contains large deposits of iron ore ;** the Kolar gold fields — I imagine the largest industry in India—are on its borders." He proceeded to enumerate the rich veins of various ores, and pointed out that the sugar-cane and opium poppy both grew in the district. He also regarded the climate of Bangalore as suitable for the Indians and Europeans alike. He was perhaps disposed to exaggerate the industrial potentialities of a hydro-electric scheme, worked from the Cauvery falls, which, he thought, would enable the city to become one of the largest owners of power in the world, with a consequent development of its manufacture. As far as the spirit of the town is concerned, the Professor found "a certain nucleus of scientific society," congenial to the staff and the students. For the initial composition of the staff, he recommended a professor of engineering technology, a professor of industrial bacteriology, and a lecturer in physics, all of whom should be provided with suitable assistants. He also advised arrangements by which each professor would have an extended vacation in which he could continue his researches, and he suggested that no restrictions should be placed upon their powers to act in a consultative capacity for the benefit of industry. The report also recommended the employment of mechanics and electricians, who could make the apparatus and teach the students to use their own hands.

Final Selection of Bangalore

Mr. Tata and his chief adviser, Mr. Padshah, were for a long time strongly prejudiced in favour of Calcutta, but ultimately they yielded to the arguments of Sir William Ramsay, and appear not only to have accepted his choice of site, but also his scheme of administration and his nominees for directorship and other appointments. In the mean time Mr. J. N. Tata died in 1904, but his worthy sons Sirs Dorabji and Ratanji proceeded with his work, and ultimately the Institute came into existence in 1911, with the objects, defined in the fifth quinquennial review of the progress of education in India (1902-1907) as follows :-

"The object of the Institute at present is that it shall be primarily an institute devoted to post-graduate study and research, particularly in science, and conducted with a view to the application of science to Indian arts and industries."

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*At present the Mysore Government grant is only Rs. 30,000.

**The knowledge of the great deposits of iron-ore in Chotanagpur which later led to the foundation of the great Tata Steel Works at Jamshedpur was quite unknown at this time.

From Foundation to 1921

With these ideals and working programme the Institute was started in 1911 with Dr. Morris Travers, who was assistant to Sir William Ramsay, as its first Director, and the following departments were opened :-

(1) Department of General and Applied Chemistry under Dr. Norman Rudolph ;
(2) Department of Electro-technology under Dr. Alfred Hay ;
(3) Department of Organic Chemistry under Dr. Sudborough ; and
(4) Department of Biochemistry under Dr. G. Fowler.

The rules for the guidance of the director and the professors appear to have been framed in accordance with Prof. Sir William Ramsay's suggestions quoted above. Time showed that they were not satisfactory, Dr. Travers resigned in 1914, and in 1921 the Government of India appointed a Special Committee to make inquiries and recommendations regarding the Indian Institute of Science, Bangalore. The personnel of the Committee included

(1) Sir W. J. Pope, Chairman,
(2) The Hon'ble Sir Ashutosh Mookherjee,
(3) Sir H. H. Hayden, and
(4) Prof. C. V. Raman.

The Pope Committee's Conclusions and Recommendations

The Committee's conclusions regarding the past working of the Institute are given in the following words :—

"The evidence placed before us makes it abundantly clear that there exists in many quarters a strong feeling of disappointment and dissatisfaction due to the present condition of the Institute. It has indeed been maintained that its work is carried on without definite aim, that it has achieved no definite position, that it has not attained academic repute."

In their recommendations, the Pope Committee laid down the general lines of administration of the Institute and indicated the lines of development. These recommendations were adopted with certain alterations by the Government of India and are in force even now. The administration was vested in

(*a*) the Visitor, who is H. E. the Viceroy of India ;
(*b*) a Court or Standing Committee of the Court :
(*c*) the Council : and
(*d*) the Senate.

The Court which is a large body and is recruited from all parts of India is merely a body on paper as it never meets. The Standing Committee of the Court is on the other hand a smaller body which has sometimes expressed strong opinions on the policy followed by the Institute. The real administrative body is the Council which is at present composed of :

(*a*) Two nominees of the Government of India ;
(*b*) „ „ „ Tata Family ;
(*c*) „ „ „ Maharaja of Mysore ;
(*d*) Four „ „ Indian Universities ;
(*e*) Two „ „ the Court ;
(*f*) Director (ex-officio) who acts as Secretary.

The Senate is a body of teachers who take decisions on academic matters and make recommendations to the Council.

The Pope Committee recommended for the Institute a principal, whose duties were defined as follows :

"Apart from scientific and administrative qualifications the principal, whether a European or an Indian, should be keenly and sympathetically interested in India, in its people, and in the development of its resources ; as the social and administrative head of the Institute, he must be capable of gaining the confidence of students, not only in his own but in other institutions, and of the distinguished Indians with whom he will have to deal. It thus seems that the principal, when not an Indian, should have considerable Indian experience."

The Pope Committee submitted a very elaborate scheme of expansion which, however, could not be given effect to.

The above short review of the recommendations of the Pope Committee shows that Sir William Ramsay's scheme of allowing the heads of departments to manage their own house, free from outside control, did not work well, and it was found necessary to put the teachers as well as the Director under rigid control by an external body representative of various interests, and to make definite rules for their guidance. Secondly, the Committee recommended a greater amount of *academization* of the Institute than had been probably contemplated by the founder.

The result was that during the next phase (1922-31) the Institute became more or less an academic body, developing more on the lines of a university devoted to training students in academic research after the postgraduate course than on any industrial lines.

Dr. M. O. Forster was appointed the Director of the Institute in 1922, soon after the publication of the Pope Committee Report, and he relinquished his charge on April 1, 1933, when the present Director, Sir C. V. Raman, was appointed.

The Second Quinquennial Reviewing Committee met in November 1930, and its personnel consisted of

(1) Lt. Col. R. B. Seymour Sewell,

(2) Professor M. N. Saha, and

(3) Major H. G. Howard.

We give below some relevant terms of reference:

(*a*) To explore possible lines of development by (1) expanding departments now operating and (2) establishing new departments. In this connection, to consider whether the Institute can undertake work of a more specialized character as distinct from the type of research work now conducted at the universities.

(*b*) To consider whether it would not facilitate the business of the Council and assist in a better understanding of departmental matters if heads of departments attended Council meetings by invitation during the discussions relating to these departments.

(*c*) To consider Sir Dorabji Tata's proposal that the directorship be abolished as a whole time post and the administrative duties of that office be discharged by heads of departments in rotation, the routine work to be done by a registrar.

(*d*) To consider possible improvements in the machinery for appointing new professors.

(*e*) To consider the terms of appointment and rates of remuneration for the teaching staff, Indian and European.

An analysis of the terms of reference, particularly (*a*), shows that there was a strong feeling in the mind of the public that the Institute was becoming too much of an academic body and was competing with universities in academic researches, and there was almost a consensus of opinion that this type of work should be dropped and the resources of the Institute should be devoted to industrial work. Further the opinion was also expressed rather strongly that the Director who, on account of official work, could not find much time for research work should be relieved of the major part of his routine administration work by the appointment of a registrar.

The Sewell Committee discovers that the Institute is a South Indian Body

From an analysis of the number of admissions to the Indian Institute of Science up to 1930, the Sewell Committee made the interesting discovery that the majority of students admitted up to 1930 came from Mysore, Bombay, and Madras, but very few from North India. These figure. are shown below;

TABLE I.

	1925-26		1926-27		1927-28		1928-29		1929-30	
	Appl.	Adm.	Appl.	Adm.	Appl.	Adm.	Appl.	Adm.	Appl.	Adm.
Mysore	25	17	18	10	16	10	35	14	57	22
Madras	50	15	57	21	48	20	39	16	45	16
Madras States	4	—	6	2	10	2	11	3	4	—
Bombay	31	12	33	16	60	26	58	15	62	22
Bengal	20	5	19	8	13	4	10	4	10	5
C. P.	4	2	6	2	7	5	5	1	4	1
U. P.	7	4	4	1	3	3	4	2	8	3
Punjab	1	—	7	1	2	—	3	1	6	3
Rest of India	12	4	5	2	11	4	6	3	9	2

Thus the hope of the founder that the Institute would serve the need of the whole of India was not realized. Commenting on this fact the Sewell Committee remarks:

"We are however strongly of the opinion that in spite of the rapid developments in post-graduate and technological work in the northern universities and institutes, this Institute will not fulfil the original intention of the founder unless it is regarded as an all-India institution, and any suggestion that its ultimate status will be that of a south Indian institute only is strongly to be deprecated. Whatever developments take place in the universities, we are convinced that with the resources at its disposal, the Institute ought always to be in a position to supply such opportunities for training as cannot be obtained anywhere else in India. This Institute should do what no other institution can do".

The Cause why the Institute was not utilized by North India

It is not difficult to find out the causes which led to a very few students from North India seeking admission into the Institute. From 1921 the Institute has been doing work more of an academic type, but in the mean time the situation in North India had completely changed. As a result of the recommendations of the Sadler Committee, the North Indian universities changed themselves from purely examining bodies to teaching ones where research was recognized to be a part of the professorial duty. So, many research centres grew up in the North and it was not necessary for students from North India to repair to Bangalore where the same type of work was being carried on, excepting partly in the Departments of Electrotechnology and Biochemistry.

The Sewell Committee recognized that the Institute would be fulfilling its purpose if the resources of the Institute were devoted to researches of an industrial nature. It quotes the following remarks from the Report of the Pope Committee:

"It should be the duty of the staff and indeed of the members of the Governing Body, who possess scientific and technical experience to acquaint themselves with those needs of India which can be served by pure or applied scientific research, and to make provision, in so far as may be possible, for the carrying out of such research in the Institute....... Every effort should be made to stimulate work of this kind (*i. e.* the establishment of new industries) for the purpose of developing the resources of India and of creating positions and careers for Indian students who have received a sufficient scientific training".

We give below the main recommendations of the Sewell Committee:

(i) That the Institute should seek to co-operate more closely with the industrial bodies in India;

(ii) That the present method of recruitment should be changed and the standing selection committees be established, one for the appointment of the Director and one for each department;

(iii) That the possibility of an exchange of staff with other universities be explored;

(iv) That the General and Inorganic Chemistry Departments be extended to include sections for work on (*a*) metallurgy and (*b*) ceramics;

(v) That the Organic Chemistry Department be extended to include a section on pharmacology;

(vi) That the Biochemistry Department be extended to include sections of (*a*) plant physiology, (*b*) microbiology, and (*c*) bacteriology;

(vii) That the Electrical Technology Department be extended to include sections on mechanical engineering and electric traction;

(viii) That a chair of applied physics be established.

After 1931—Fate of the Recommendations of the Sewell Committee

These salutory recommendations of the Sewell Committee do not, however, appear to have found favour with the authorities. The standing selection committees were not established and this led to great difficulties in the matter of appointment of the professors and the two selection committees, one in England and the other in India, went on playing a game of battledom and shuttlecock with the result that some important chairs remained unfilled over years. Secondly, in the matters of junior appointments all power was vested in the Senate which from its cons-

titution is completely under the domination of the Director. On the other hand, Sewell Committee proposed a selection committee composed of experts recruited from the best elements in India. The non-adoption of these resolutions has, as will be shown later, led to very unsatisfactory results.

After 1933

The new Director, Sir C. V. Raman, took charge on April 1, 1933. He came with a great reputation as the only Indian Nobel Prize winner in Science and with a record of very important researches in physics carried out under the auspices of the Calcutta University in the Indian Association for the Cultivation of Science. It should however be emphasized that he had no administrative experience of a big institute as his duties at Calcutta consisted merely in guiding research work of his scholars in physics. Also he had no experience of research work in any applied science. But he was under no illusion regarding the duties and responsibilities of his new post, as shortly before he was appointed to the post he declared in a public lecture that if he were given ten lakhs of rupees (whether endowment or recurring income, not quite clear) he would revolutionize the industries of India in course of ten years. This shows that before joining his post he wanted to create in the public mind an impression that if he were placed in charge of the Indian Institute of Science he would devote his whole attention to research work of an industrial type in conformity with the desire of the founders. Further, as he had spent the major part of his active life in the cosmopolitan atmosphere of Calcutta, it was expected that he would maintain an all-India outlook in the matter of appointment to new vacancies and admission of students to the Institute.

Creation of a Department of Pure Physics

The Sewell Committee after fully considering the original object of the donors and the development of scientific research in India recommended that the Institute should have a department of applied physics. It strongly deprecated that the Institute should duplicate the work that is being done at the universities and other research institutes. No university in India, except Calcutta, has a department of applied physics; so it is needless to add that the opening of such a department would have added to the usefulness of the Institute to India. There are many important industries, like glow-lamp industry, refrigeration, metallurgy, glass, which depend upon a sound knowledge of the fundamentals of physics, and as India does not possess these industries, researches on their development should have been amongst the first duties of the Institute. The Council no doubt created a department of physics when the new Director took charge, but omitted to define its activities. The result is that in the hands of the new Director it is fast developing into one for pure research. As far as our knowledge goes, no industrial work has been carried on in the new department within the last three years and recently the Council passed a resolution creating a chair of theoretical physics on a salary of Rs. 1250-1500. The published papers from the Institute show that the Director is simply developing his old lines of research at Calcutta and has not undertaken any research work in industrial physics. We have read the whole history of the Institute and the recommendations of the different Reviewing Committees, but nowhere we find that the creation of a chair for theoretical physics was even contemplated either by the donors or by any of the Reviewing Commitees. We are happy to note that we are not alone in our protest against the creation of a chair of theoretical physics for the Institute and the type of work that is being carried out in the physics department of the Institute. Some time ago, Sir M. Visvesvaraya, the Chairman of the Standing Committee of the Court, circulated a note pointing out that the resources of the Institute were being utilized only for pure research and industrial work was being neglected. Thus, in spite of the warning of the Sewell Committee and in violation of the hope raised by the Director himself in the minds of the Indian public, the Institute is being taken away from its original ideal by undisguised academization of its activities.

The Task before the Reviewing Committee

We have finished our brief review of the history of the foundation of the Institute and its activities since then, and we hope that our review will enable the public to have a correct idea of the ideal and programme of the work to be pursued by the Institute.

The task before the Reviewing Committee is quite clear. They must find out what the Institute has done for industrial research and whether its present programme will take it towards that goal or only further away from it? They must find out whether the employees of the Institute are sufficiently safeguarded by the rules and the statutes, and can carry on their activities in a calm atmosphere. They should also enquire in the light of the happenings of the last five years, as regards the admission and recruitment of the staff, whether the Institute was serving as an all-India body, or has become a South India one as apprehended by the Sewell Committee. We think that the Committee should undertake a tour of the educational and research institutions of India, and compare the present state of scientific research in India with that prevailing at the time of the foundation of the Institute, and thus advise the founders whether a definite programme is not more desirable than an indefinite one so far pursued by the Institute. "Conditions in this world are always changing," remarked Andrew Carnegie, while making over his whole fortune to the American nation, "and I impose no limitation on the Trustees of my Bequest—they should have full power to disburse the income according to the changed conditions." We hope that the report, when it comes out, will be acceptable to the founders, and will not be shelved by them, as was the fate of most of the recommendations of the Sewell Committee.

Water Storage and Power in India

The possibilities of large scale water storage and power development in the upper reaches of the Himalayan rivers was the subject of an extremely important paper before the *Institution of Engineers (India)* by Mr. J. W. Meares. The paper presented in greater detail the proposals put forward by Mr. Meares in the Triennial Report of the Hydro-Electric Survey of India. Briefly the proposal consists in constructing storage lakes on a large scale by means of hydraulic fill or blasted earth dams of great length and height with by-pass tunnels of sufficient capacity to prevent the dam being topped and destroyed by a flood. The method is, of course, as close as possible an approximation to the work of nature. It is certain that, but for flooding, a large number of landslip dams would have already been formed in the Himalayas through the operation of natural courses. The by-pass tunnel is the remedy. Most of the Himalayan rivers have comparatively gentle slopes in their upper regions. The Indus, for instance, from its source to the base of the mountains falls only at the rate of 15 ft. per mile.

In view of the urgent need for irrigation in Northern India it is clear that such proposals, involving as they do a minimum of construction cost and with their favourable effect on electrical power production, should be examined over again very carefully. The average annual rainfall of the region is not exceptionally heavy (37·5 inches), and of this the Indian Irrigation Commission have estimated that 35 per cent is carried away to the sea, 6 per cent used for irrigation, and the remainder evaporated or absorbed. —*World Power*, January 1936.

Science in the Service of Indian Agriculture*

Sir Bryce C. Burt

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May I first say how much I appreciate this opportunity of saying something about science in relation to Indian agriculture to so representative a gathering of scientific workers and others interested in scientific subjects. I must admit that I had considerable difficulty in selecting a title and deciding on the scope of my lecture. Agriculture and the agricultural population in India, as in the rest of the world, have of course benefited greatly from the material results of scientific discoveries. The rural population in India has benefited greatly from the material discoveries of science, for example, in better transport, better illumination, and the telegraphic service. More recently, we have seen the extension to villages, especially in the United Provinces and Mysore, of the benefits of hydro-electric development whilst one of the most recent of scientific developments wireless broadcasting—is now being brought to the villages in increasing degree. All such discoveries help to raise the standard of comfort and efficiency of the rural population.

Many of you are also familiar with several of the more spectacular applications of science to agriculture, for example, the recent use of aeroplanes for locust destruction campaigns in the Near East and the application of insecticides in America in campaigns against the cotton boll weevil and certain pests of sugarcane. But when one speaks of science in relation to agriculture, the picture conjured up in the minds of most people is enshrined in the old blessing on him who causes two blades of grass to grow where one grew before. Of recent years, the truth of this old adage has been called in question by some economists, but at last it is being realized that the world at present is suffering not so much from over-production as from under-consumption and maldistribution, and that the application of science to the improvement of agricultural problems is as necessary as ever.

I think that we shall all agree that by far the greatest service which science has rendered to Indian agriculture, transcending even the material benefits, lies in the application of the scientific *method* in the solution of agricultural problems. Agriculture itself is not a science but is largely an art and nowadays it is perhaps primarily a business, since the greater part of the population of the world still obtains its living by tilling the soil. But agriculture is something deeper and more fundamental than mere business, for it has an importance in the national life of even the most advanced countries denied to other occupations, doubtless for the reason that its roots go down to the very beginning of civilization. Man might even be said to have first been differentiated from the other animals when he made the conscious decision to keep flocks and herds of his own instead of depending on the luck of the chase, so that animal husbandry must take precedence of agriculture proper in point of antiquity. The next great advance was man's decision to grow crops for his own use instead of depending solely on his flocks and such produce as he could collect in the jungle. Precisely when and how these advances were made, archaeologists have not yet been able to tell us, but one might safely hazard the guess that in each case it was a woman who got the brain wave and decided that her husband's time could be employed to better advantage at home than in the jungle.

Agriculture has grown up as a result of experience or, in other words, on a system of trial and error and empirical experiments. The conscious application of modern scientific method to the problem of agriculture is barely a century old, but for many centuries previously an immense amount of

* Lecture delivered at the twentythird Annual Meeting of the Indian Science Congress, Indore, on the 3rd January, 1936.

agricultural lore was stored up in books, sacred writings, proverbs, and traditions. Much of this empirical knowledge is still of great importance and has not yet been scientifically interpreted. Our methods of tillage and soil management, for example, are still largely traditional though based on long and sound experience. To quote another familiar example, one would have to go exceedingly far back in the history of mankind to trace the first emphasis on the value of butter and fresh vegetables in the human diet, and yet it is only in recent years that the complete explanation has been found in the discovery of the vitamins.

It was natural that with so much accumulated experience, the first instinct of settlers in new countries and equally of those concerned with the improvement of agriculture in backward countries was to copy in detail the methods of more advanced countries. This phase occurred in India quite early in the 19th century. For instance, the East India Company decided over a hundred years ago to do something for the improvement of cotton growing in the Bombay Presidency and in 1839 imported 12 American cotton planters to show how cotton should be grown. As one might expect, the results of this effort were not entirely satisfactory though it left its mark. In 1864, the Government of Madras thought that India should adopt modern agricultural implements, and so imported a steam-plough with a complete set of implements and many accessories, and started a new farm on which to use it. Subsequently, a model farm was developed at Saidapet on which western methods of agriculture were demonstrated. Similarly, Bengal had seven model farms as early as 1871 and the United Provinces at least three for some years prior to 1875. These early efforts to make a real mark on Indian agriculture failed because they were merely attempts to copy the methods of other countries.

The first real example of the application of scientific methods to agricultural problems came about 1875, it was not however in the application of natural sciences that the first advance was made but in the systematic study of the economic problem. The first landmark is the report of the Famine Commission of 1880, for it is to the recommendations of that Commission as emphasized and elaborated by the next Commission of 1901 that we owe the great development in irrigation, communications, agricultural credit, and last, but not least, the establishment of what eventually became departments of agriculture in each province. Those departments were first charged with the study of village conditions, the development of proper agricultural statistics and the development of a sound land revenue system, so that for the first time there became available a proper knowledge of the economic background of Indian agriculture in each province.

In the United Provinces, a department of agriculture was started in 1875, and the first experimental farm in India was opened at Cawnpore by the late Sir Edward (then Mr.) Buck who had been impressed by the value of the now famous work of Lawes and Gilbert at the Rothamsted Experimental Station which was founded in 1843. With a breadth of vision, remarkable for his time, Buck realized that the use of the experimental method was essential if any improvement was to be effected in Indian agriculture. At the invitation of the Government of the day Dr. Voelcker, the famous Agricultural Chemist to the Royal Agricultural Society of England, visited India in 1889 and this marked the first endeavour to organize agricultural research in India. There is much in Dr. Voelcker's book, *The Improvement of Indian Agriculture* which is still as true and as valuable as when it was written. The year 1892 saw the appointment in the Bombay Presidency of the first Technical Deputy Director of Agriculture, Mr. James Mollison, who afterwards became Inspector-General of Agriculture in India and who was very definitely the pioneer in all real field experiments in India. In the same year the Government of India decided to appoint an Imperial Agricultural Chemist. Dr. J. W. Leather, who is affectionately remembered by dozens of officers still serving in India, was appointed and was the first scientific officer of the Indian Agricultural Department. The year 1898 saw the arrival of the first Agricultural Botanist. Dr. Barber, who also was the personal friend of many of those present today, was brought from the West Indies and appointed Economic Botanist to the Government of Madras, in order to deal with an outbreak of sugar-diseases. He solved this problem by the introduction of disease resistant types of cane, a step of great scientific and technical importance. In 1901, the Government of India appointed an Imperial Myco-

logist, Dr. E. J. Butler, who subsequently became the head of the Imperial Mycological Institute, London, and in the same year decided to appoint an Inspector-General of Agriculture. If these early attempts at Government assistance to agricultural development now seem halting and inadequate, we must remember that in England agricultural improvement in those days owed little to Government aid but much to enlightened landlords, and indeed, Government interference was not always welcome. Agricultural science was still in its infancy and had not established its position amongst practical farmers.

The Famine Commission of 1901 endorsed the recommendations of its predecessor of 1880, and Lord Curzon's Government speedily took action to translate the remaining recommendations into effect. One result was the creation of an Imperial Department of Agriculture and the setting up of the Pusa Agricultural Research Institute and the provision of properly equipped technical and scientific departments of agriculture in the provinces. From that day onwards there has been steady progress in the solution of Indian agricultural problems and in the application of the scientific method to this end. Thanks to the wise and far-reaching recommendations of the Royal Commission on Agriculture and its distinguished Chairman, Lord Linlithgow, our Viceroy-designate, agricultural research can now be organized and financed with a precision previously unknown. Means have been created by which research workers in all branches of science in the universities and similar institutions can be linked up with the agricultural departments. The stage is now set for a further great advance in rural uplift.

I trust that this brief historical survey, covering grounds which must be familiar to many of my hearers, has not been tedious. I will now turn to some of the ways in which the different sciences have contributed to Indian agricultural improvement, and it will be seen that each science in turn has been drawn upon and has made its contribution. I need hardly add that every great advance in pure science renders possible an attack on some agricultural problem from a new angle. Though agriculture itself is not a science, it is now the custom to speak of agricultural science and quite rightly we have a Section of Agriculture in the Indian Science Congress. The reason is that agricultural science covers such a group of border-line problems that wide knowledge rather than a specialist outlook is called for. Moreover, field experimentation itself is rapidly becoming a definite branch of science for which one would like to see the term 'Agronomy' reserved. Here a word of explanation is due from me. I propose to use the term 'Agriculture' not as including all branches of farming but in its narrower sense, that of field cultivation. In other words, I shall omit animal husbandry, despite the importance of mixed farming in modern agriculture, and limit my remarks mainly to crop production or plant industry to adopt the descriptive title chosen by my old colleague, Sir Albert Howard, for the Institute at Indore which he founded. Considerations of time also necessitate my omitting horticulture and to a great extent the plantation crops like tea, coffee, and rubber. Lest my silence be misunderstood, let me also say that I am not unmindful of the stupendous services which the science of engineering has rendered to Indian agriculture. Irrigation, drainage, and improved transport have banished the spectre of famine. But a separate lecture and a better qualified lecturer would be needed to do justice to that great subject.

Our ultimate aim is an improvement in the *efficiency* of agricultural production and distribution, especially the former. This connotes the bringing to the agriculturist of a larger profit, or at least a larger reward, for his endeavour. In India with an abundant labour supply and relatively small cash payments this generally means either an improvement in the yield per acre or in the quality of the produce or both. Reduced to simple terms, this involves one or both of two things: the improvement of the plant and its better nutrition. Perhaps one should add a third, though it is partly contained in the first, viz. the better protection of the plant against pests and diseases. In India more progress has been made in plant improvement than in better plant nutrition. The reasons are partly economic and partly technical. Economic because the adoption of improved seed made the minimum call on the peasant's 'limited' financial resources. Technical because the re-organization for the agricultural departments in India coincided with a period of rapid advances in the science of genetics and in the application of these principles to practical plant-breeding. Very naturally the improve-

ment of the Indian staple crops received immediate attention with the result that today the ascertained area under improved strains, issued by the agricultural departments, is not less than 16 million acres, the probable area being very considerably greater as it is almost impossible to trace the natural spread of an improved seed.

Wheat was one of the first crops to come under study and as a result of the work of the Howards at Pusa (since continued by Dr. Shaw), of Milne in the Punjab, and Evans in the Central Provinces, there are now about six million acres of improved wheats under cultivation. Figure 1 shows the relative yields at Shahjahanpur farm, United Provinces, of Punjab 8A, Pusa 4, Pusa 12, Cawnpore 13, Pusa 111, Pusa 112, Pusa 113, and Pusa 114. It is of interest to note the very high level of these yields which have only been obtained by combining improved cultivation and rational manuring with the use of an improved variety. For a detailed account of these wheats see the *Indian Journal of Agricultural Science*. At this farm improved sugarcanes are grown by improved methods, the wheat being a rotation crop, so that we have here an exceedingly fine illustration of efficient farming, the principles of which were explained by Mr. Clarke in his presidential address to the Agricultural Section at Allahabad in 1930. Of special interest is the seven-year average yield of Pusa 12 wheat compared to the local variety, the yield of Pusa 12 – 30 maunds per acre – being very nearly double that of the local wheat.

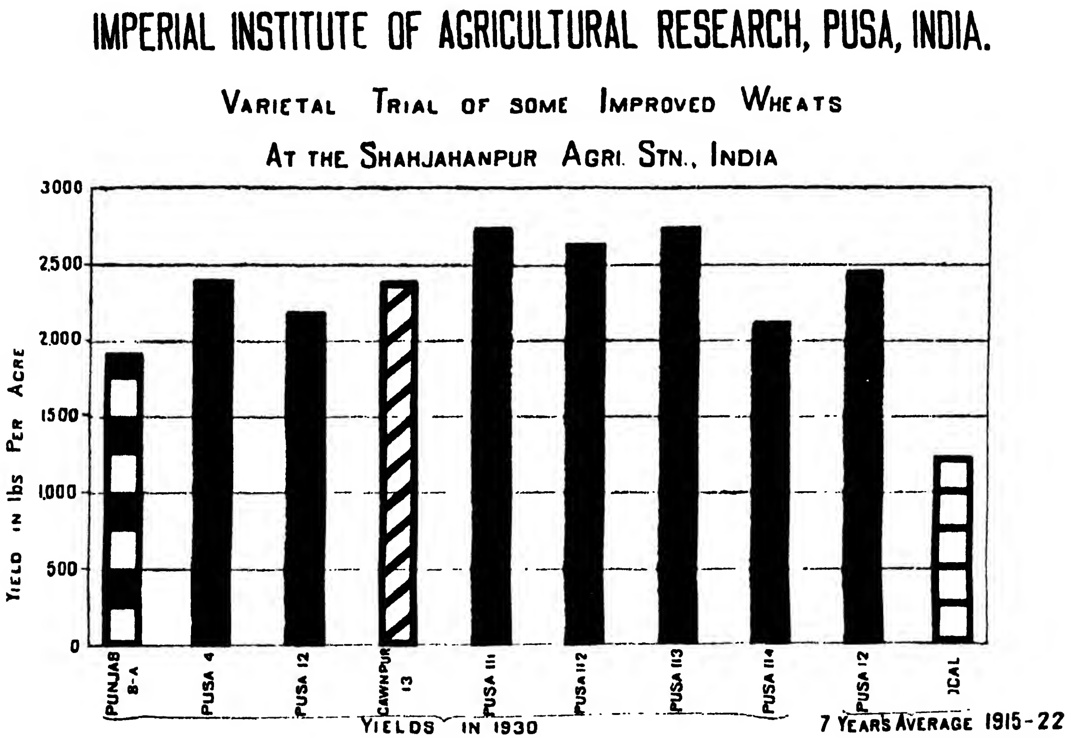

FIG. 1.

All the Pusa wheats in this set are wheats of high milling value, Pusa 111 which is one of the latest has been reported by the Director of the Research Association of British Flour Millers to be fully equal to Manitoba, whilst repeated experiments in India show that they are popular for home consumption.

The percentage of flour is one of the commercial characters of wheat which has a considerable effect on the price paid for it. All the Pusa wheats, before introduction into general cultivation, have undergone

exhaustive milling and baking trials. For most of these we were indebted to Mr. Humphreys, for some years President of the National Association of British and Irish Millers, who collaborated with the Howards for several years. Pusa 12, which now occupies so important a position in the United Provinces, was selected for general distribution because it combined high yield, earliness, and hardiness with good milling and baking quality and behaved consistently when grown at a number of different centres during several seasons.

To turn to other crops, I may mention the improved Pusa tobacco, a hybrid between the well-known Virginia cigarette tobacco Adcock and Pusa 28, one of Howard's early selections. The object here is to combine quality with the valued agricultural features of the indigenous parent. I need not emphasize the subtle nature of quality in cigarette tobacco and the importance of environment as a modifier of hereditary characters. Incidentally the tobacco work at Pusa involved a good deal of experimental work on flue-curing.

FIG. 2.

OIL CONTENTS IN SOME PUSA LINSEEDS

Variety		Oil Percentage
Type	12	37.14
Hybrid	10	43.05
Hybrid	11	44.11
Hybrid	23	43.12
Type	121	40.14
Hybrid	55	42.81
Hybrid	68	42.13

Fig. 2 shows the practical side of linseed breeding, the cages being used to prevent cross fertilization, and the results of a cross between the local type 12, which by its root system and agricultural habit is adapted to the conditions of Indo-Gangetic Plain, and a bold Central India type with high oil content. Linseed is one of our most valuable export crops and Indian linseed already commands a premium in world markets, but competition is keen and there is still scope for further advances.

Another aspect of plant breeding is the production of disease-resistant strains; work of considerable value on this subject has been done on Arhar (*Cajanus indicus*), one of our most important pulses.

Another direction in which very marked advances have been made in varietal improvement is to be found in sugar. This work was started many years ago by Dr. Barber and he laid the foundation of the present modern sugar industry in India. You are all familiar with the advance which has been made and it is sufficient here to say that whereas in 1929-30 India produced only 111,000 tons of sugar and imported over 900,000 tons, Indian production of factory sugar in 1934-35 was over 600,000 tons with a corresponding diminution in imports. When all the new factories are working to full capacity India will be approximately self-supporting in sugar.

Most members of the Science Congress are familiar with the work that has been done at Coimbatore, and know how Dr. Barber and Rao Bahadur Venkatraman successfully used hybrids of the wild cane, *Saccharum spontaneum* (or *Kans* grass which we see so commonly round Indore), with noble or tropical sugarcanes to produce canes combining with satisfactory sugar content the disease-resistant and other properties required for satisfactory growth in Northern India. At Coimbatore also physiological work of very considerable importance has been carried out, especially on the state of the root system of sugarcane and the manner in which they are developed. Here let me emphasize the very great importance of a complete botanical and physiological study of each of our crop plants. A further study of the anatomy of the sugarcane plant would enable us to breed with more precision a type of plant which will combine with other good qualities a stem structure enabling it to resist the tendency to lodge. Lastly I should mention the hybrid between sorghum and sugarcane, the economic potentialities of which have still to be worked out but which, being an inter-generic cross, is of very great scientific interest.

Yield and hardiness have not been the only consideration, for the Coimbatore canes were only issued after rigid chemical and factory tests. They are now

grown on a very large scale occupying some 60 per cent of the total sugarcane area.

These two examples illustrate the work which has been done by botanists in India in the direction of varietal improvement. But the botanist must not be left to work alone. The analysis of the factors which determine yield and quality in agricultural crops calls for all the aid that other branches of science can give. I have already stressed the importance of quality in agricultural produce and would now invite your attention to some examples of the aid which physical science has given to agricultural improvement in regard to the cotton crop.

Cotton is grown in order that it may be spun and woven, and consequently the testing of the plant breeder's productions for spinning quality is exceedingly important. High yield and a high proportion of cotton to seed do not necessarily coincide with good spinning quality—indeed the reverse is often the case. The Indian Central Cotton Committee therefore decided to set up a central technological laboratory in Bombay which would undertake three main functions.

(1) The practical testing of new cottons for agricultural departments by actual spinning tests on specially designed machinery enabling small samples of 4 lbs to be spun. This trial includes the complete testing of the yarn and gives a very fair estimate of a new cotton's potentialities;

(2) the study of the fibre characters of cotton and the designing of new methods, applicable to small samples, of determining the measurable characters of the cotton hair;

(3) to work out the relationships between the measurable fibre characters and spinning behaviour in order that agricultural research workers concerned with cotton improvement might eventually have suitable means of fibre testing at their disposal. Much progress has been made on these lines. The chances of a cotton of unsatisfactory commercial characters passing into general cultivation are now negligible whilst agricultural departments are in a much better position to decide which of several promising types is likely to be the most satisfactory in the long run.

The Technological Laboratory is fully equipped with instruments for testing the individual tensile strength of the cotton hair, the torsional elasticity of the cotton fibre, the twist and strength of yarns. Dr. Nazir Ahmed, the present Director, has devised a new stapling instrument for determining the mean fibre length and the mean fibre weight per inch—the latter number being a useful factor in the prediction formula connecting the fibre character of a cotton and its spinning value. In this laboratory studies are also in progress on the damage that takes place in cotton during storage. We can now understand why there is such loud and constant protests from spinners against the damping of cotton in pressing factories, which is very favourable for the growth of fungus mycelium.

Fig. 3 shows the complete set of spinning machinery at the Technological Laboratory, Bombay, except the blow-room in which the cotton is cleaned. In this spinning laboratory cottons can be tested for their spinning capabilities under known but varied conditions.

Next comes the yarn testing which is of primary importance because it is necessary to be able to state that *good* yarn of a certain count can be *economically* made.

Put briefly and in non-technical language, a good yarn must reach certain standards of strength and evenness, with not more than a certain degree of twist, and the breakages in spinning must not exceed the recognized standard.

One aim of the Technological Laboratory is to establish a prediction formula by the aid of which the spinning capabilities of a cotton could be calculated from hair measurements, thus largely avoiding the need of practical spinning trials except as a final confirmation. Part of the distance has been covered but much more work is, however, required in this direction. Of the other side of the picture—the application of scientific knowledge to spinning processes—I will not attempt to speak tonight.

I have devoted some time to quality in cotton because the Technological Laboratory, Bombay, is in many ways a unique institution, and India has un-

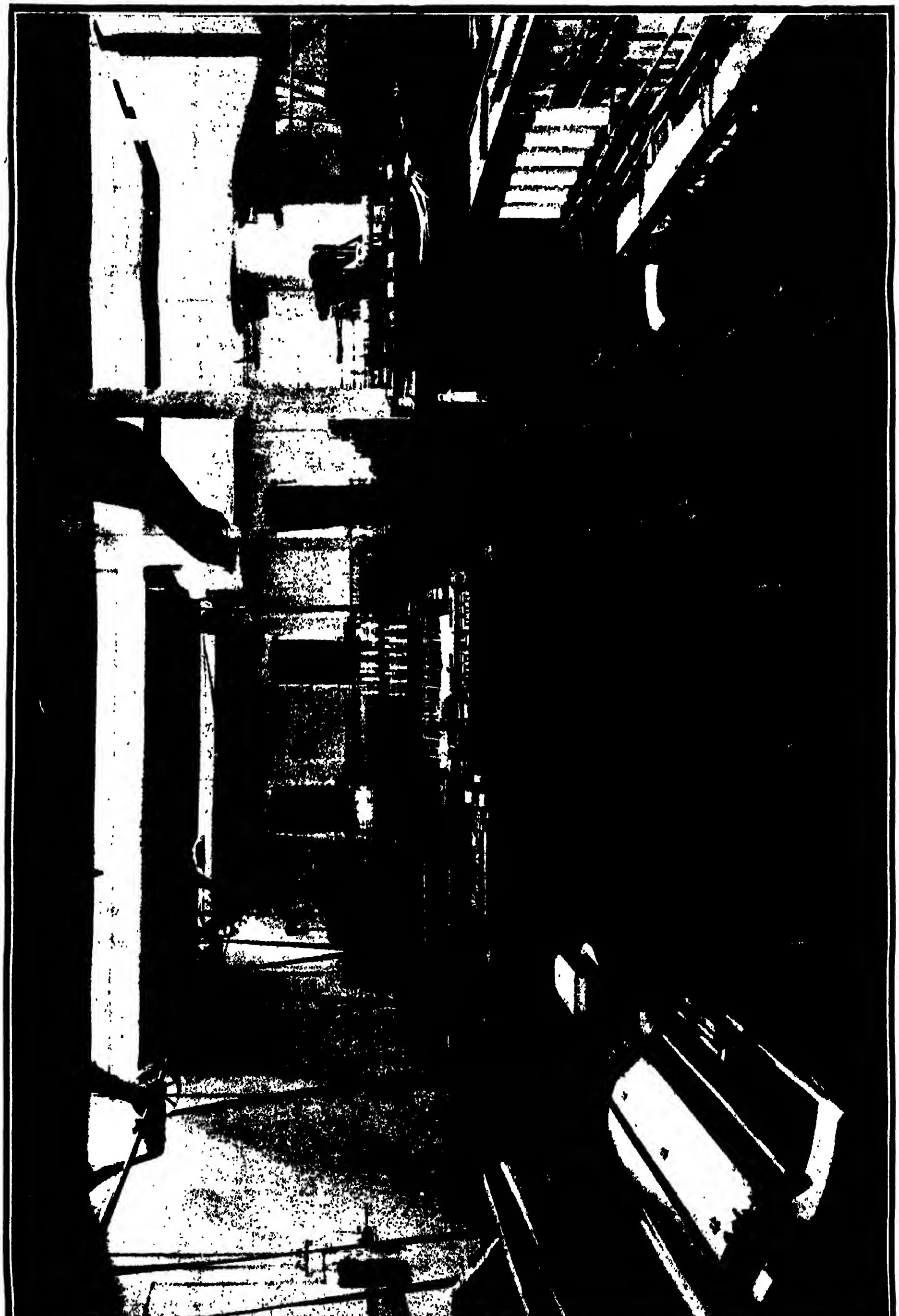

Fig. 3.

doubtedly gone ahead of other cotton-producing countries in this particular application of science to agriculture. Secondly, cotton well illustrates the fact that if we do not call all the resources of science to our aid in the improvement of our raw materials our agriculture will suffer. Modern industry makes increasingly rigid demands, and natural products are open to steadily growing competition from synthetics. Rayon has not only caused unemployment amongst the silk-worms, or perhaps I should say, the rearers of silk-worms, but is steadily eating into the field previously occupied by cotton.

Before leaving the subject of cotton I should like to say this: The work of agricultural departments in India during the last 25 years, supplemented since 1921 by that of the Indian Central Cotton Committee, has materially altered the whole character of the Indian cotton crop. The area under improved kinds is about 4 million acres, much of this area being under cottons of improved staple. I have made a rough calculation that but for these improvements Indian mills would today be importing annually close on half a million bales of foreign cotton at a cost of 7 or 8 crores of rupees instead of about a tenth of that quantity. The moral need not further be pointed out.

So far I have dealt mainly with the plant itself and I must now refer briefly to other side of plant industry studies, *viz.* soil and plant-nutrition problems. From historical standpoint this aspect of agricultural research should perhaps have come first, for in the early days agricultural science meant agricultural chemistry and the first application of the scientific method was the chemical study of soils, manures, and manuring. The early work of Lawes and Gilbert laid the foundations of a scientific explanation of soil fertility and manuring for higher production. How ably their successors at Rothamsted, Sir Daniel Hall and Sir John Russell, have carried on the tradition you all know. Research work on soils in India has rather lagged behind other branches of agricultural science, possibly because many of our soil problems are so different from those of temperate climates. Pioneer work on Indian soils was done by Leather and Harrison, and Clarke in a memorable presidential address to the Agricultural Section of the Congress in 1930 summarized the result of many years of work at Shahjahanpur on the maintenance and raising of the level of fertility. Many of us had the privilege of hearing the presidential address to the Science Congress in 1926. Himself a most successful plant-breeder, Sir Albert Howard also has been a consistent advocate of the fundamental importance of proper soil aeration, drainage, and the maintenance of the supply of organic matter. Field experiments and laboratory work alike in various parts of India have emphasized the predominant importance of organic matter in determining the fertility level in Indian soils. The Indore work on composts started by Howard and elaborated by his successor, Mr. Jackson, has provided a means of filling that want. As there is to be a special symposium this week on that subject I will not elaborate it: especially as you will all have an opportunity of seeing scientific soil management for yourselves at the Institute of Plant Industry. This however should be said. Indian soils are only very rarely deficient in potash or any of the minor fertilizing elements and though certain definite areas are the better for phosphatic manuring we know how to remedy that shortage. Most Indian soils, however, are deficient in both organic matter and nitrogen and the two most important means at hand are green manuring and the use of composts.

Since I had the privilege of addressing a joint meeting of several sections of the Science Congress in Allahabad in 1930 on the question of agricultural research, the Agricultural Research Council has been able to assist several investigations in soil science. At Dacca University we now have in progress a series of investigations on the laterite soils of Eastern Bengal and on the nutrition of the rice plant. In Calcutta Professor J. N. Mukerjee, with whose work in colloid chemistry many of you are familiar, has tackled the question of soil colloids from the physical-chemical aspect. In Bombay Deccan and in the Central Provinces, in connection with sugar and rice research schemes respectively, a systematic study of the local soils by modern methods is being undertaken. These are a few examples. I will not dilate on these researches for I see that there are 16 papers on soil problems for discussion in the Agricultural Section, and the Indian Society of Soil Science only yesterday held a scientific meeting to discuss soil surveys.

Plants, like human beings, require water even more than food and rapidly react unfavourably to a shortage of it though wonderfully adaptable in many ways. Equally, most of them are rapidly intolerant of excessive moisture around their roots. It follows that a soil's power of absorbing and retaining an adequate amount of water for subsequent delivery to the plant is of vital importance. Many of you will remember a lecture by Dr. Harold Mann at the Bombay session of the Science Congress, 1926, when vividly described the precarious situation of certain Deccan districts like Sholapur and Ahmednagar where the rainfall is both scanty and uncertain. Before he left India a technical study of this problem with the object of testing and applying 'dry-farming methods' was begun. In 1933 the Agricultural Research Council decided to give financial assistance to a co-ordinated group of dry-farming research schemes in which Madras, Bombay, and Hyderabad are co-operating in an attempt to place crop production on a more stable basis in these areas. A grant has also been made for similar work in Rohtak District of the Punjab. Now, in many ways the Indian *ryot* is very skilled in moisture conserving methods of tillage, and indeed 'dry-farming' had been practised by cultivators in the United Provinces and Bihar for centuries, so far as their resources in implements and crops permitted. But we can improve both the crops and the implements, and at the dry-farming research station progress is being made both in the retention of more moisture for the use of the plant and in the selection of drought resistant strains and crops which will make the best use of a scanty supply. Time will not permit of a detailed description. I hope that in the near future it will be possible to hold a symposium on crop production in areas of precarious rainfall where irrigation cannot be extended.

At the other end of the scale, *viz.* means of enabling the soil to get rid of surplus water, I should like to make brief mention of the work in progress in Sind and the Punjab on the prevention or elimination of water-logging in canal areas and the avoidance and reclamation of alkali. The research branch of the Irrigation Department has in each case made substantial progress towards the solution of a very difficult problem. Time will not permit even a brief survey of the work on plant nutrition. I have already stressed the fundamental importance of organic manures but artificial fertilizers also have their place. In certain well-defined circumstances, they are definitely economic. It is of interest to note that whereas India had to export a considerable proportion of the ammonium sulphate she produced she now uses the whole of this production of 13,000 tons in 1934-35 and also had a *nett* import of 38,000 tons as well as 7,000 tons of ammonium phosphate fertilizers. Much of this quantity has been used for plantation crops like tea but no small proportion has gone on such crops as rice, sugarcane, and vegetables.

However, we must pass on, and manuring naturally brings one to the subject of field experiments. The final test of any agricultural experiment must be an accurate field trial and of recent years much progress has been made. At first sight it seems easy to decide whether or not a fertilizer or crop is an improvement—it sounds so simple to try both in the same field and see which does best. But no field is even approximately uniform. The most even field of wheat, for example, if harvested in small squares, shows the most surprising variations in yield per acre. And there are so many accidents which may happen to a growing crop. Dreadful doubts begin to assail one, and one wonders what are the odds that the difference between two plots is really due to difference of variety or treatment and not to chance. Put in this form, the question can be answered if the plots are adequately replicated and the correct formulae used. Here mathematics comes to our aid and the lay-out of field experiments can now be undertaken with precision. In the interpretation of other biological data also, the aid of the mathematician is of the highest value. This want the Imperial Council of Agricultural Research has been able to fill to a considerable extent.

Turning now to the last of my three main divisions, the avoidance or reduction of the loss of crop caused by pests and diseases, you will all agree that science should be able to do something here and I have one or two illustrations of interest.

Insect pests levy an enormous toll on our agricultural wealth and there is a need for all the help that zoologists and entomologists can give us. Those of you who come from the United Provinces and Bihar have heard a good deal during the last few months about sugarcane borers.

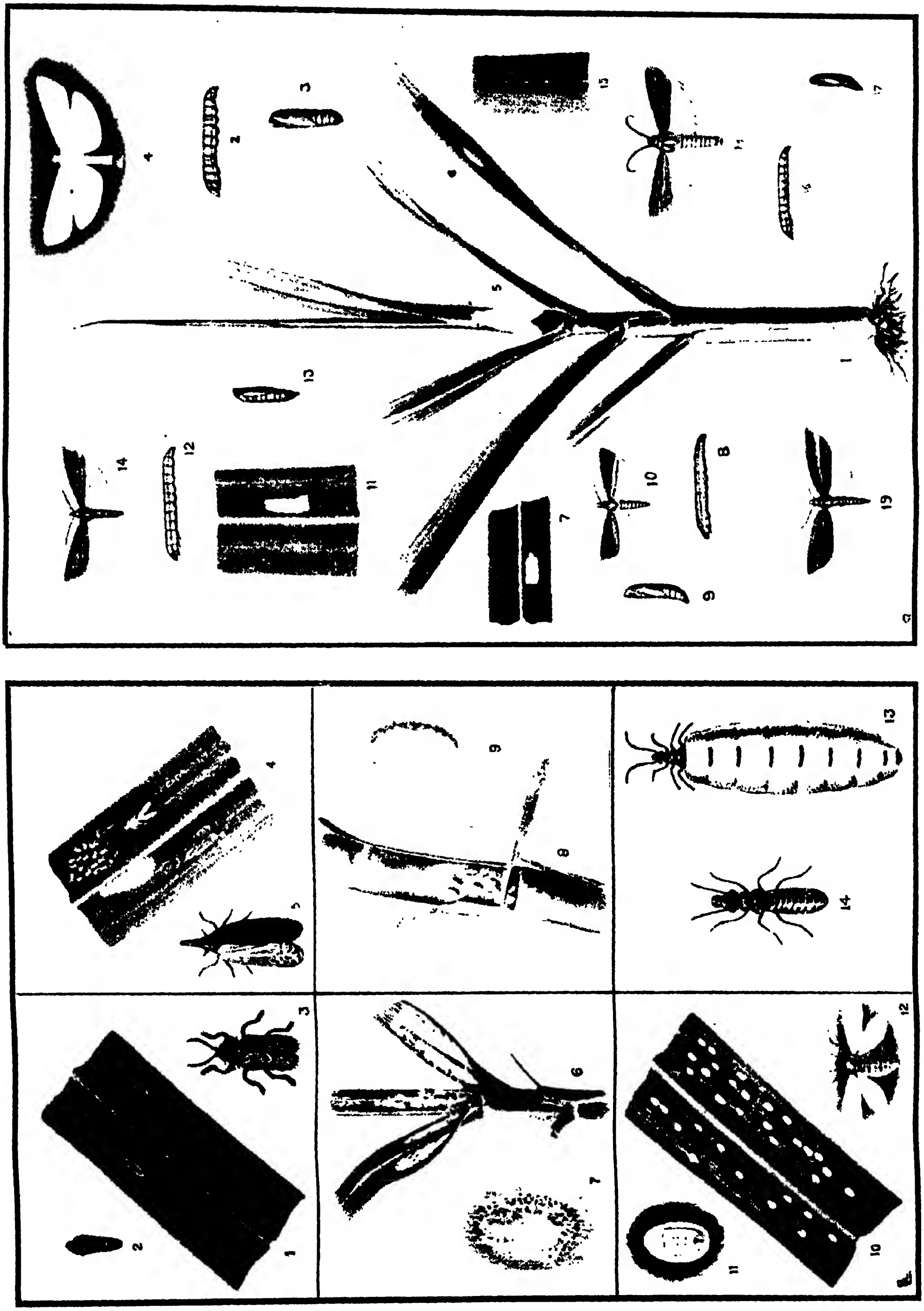

FIG. 4.

Fig. 4 gives a picture of some sugarcane pests, Hispa, Pyrilla, Mealybugs, Whitefly, Termits.

Against sugarcane pests much can be done by the proper selection of varieties, by a rational system of cultivation and the avoiding of ratoons. Some of the borers can be controlled, in part, by dusting and there is hope of control by biological methods. More work is required and the Research Council hopes to finance a scheme in the near future.

The pink boll-worm of cotton is a pest which we do know how to control in northern India by a simple method of seed treatment. It has been demonstrated in the United Provinces on two large blocks, aggregating 46,000 acres of cotton, the increase in monetary return per acre being 25 to 50 per cent according to the severity of the attack in non-treated areas. The pink boll-worm is no respecter of persons, and attacks all cottons alike. But, as Richards has shown, control is quite feasible and the pink boll-worm could be practically eliminated. All that is necessary is to heat all cotton seeds in a steam-heated machine before it leaves the ginnery. Neither the germinating capacity nor the oil-content is adversely affected. The small quantities kept in villages can be simply treated by exposure to the sun in April and May.

The spotted boll-worm of cotton (*Earias* species) has been studied at Surat, and simple control measures designed. The pest hibernates mainly in the old cotton roots and stems, and can be effectively controlled by the timely removal of cotton stumps over a sufficiently large area.

The flight range of the moths being considerable, the control of either pink or spotted boll-worm means co-ordinated action over many square miles.

Turning now to plant diseases, many of these are due to *fungi*, others to bacteria, and yet others to pathogenic filterable viruses. I have already mentioned one instance of the combating of disease by the use of immune or resistant strains and this, in India especially, is our best weapon. Proper cultivation and suitable rotations are often effective in keeping diseases in check, especially if combined with a wise choice of varieties.

Direct methods of control have been found to be economic in some cases, *e.g.* the spraying of Bordeaux mixture in arecanut gardens in the Mysore State has eliminated the diseases of this plant.

Coffee is an example of a crop which suffers considerably from disease if special measures are not taken. Like all orchard crops regular timely spraying is necessary.

I should have liked to say something about improved implements, for few people realize what has been done in this respect, and how many thousands of improved ploughs, for example, the agricultural departments have sent out, but time does not permit. I will, however, trespass on your patience by mentioning one recent invention, the result of private enterprise—the pneumatic tyred bullock cart. Exhaustive trials have shown this to be a sound economic proposition—it employs a modern low pressure tyre which is practically unpuncturable—except by sharp cutting implements.

Speaking broadly, the pneumatic tyre increases the hauling capacity of a pair of bullocks by about 50 per cent, and there is less strain and jerking and fewer sore necks.

This brings to a close a somewhat disjoined and rambling account of a few of the applications of science to agriculture. I should like you to go away with this thought: The scientific worker in India, whatever his special subject may be, will find a wealth of material for research in our agricultural problems. He will find problems intricate enough for the most ambitious. In all applied science the most important problems often lie on the border line of two or more pure sciences. Their successful solution often leads to an advance in general knowledge or to the opening up of a new field of scientific investigation. This is particularly true of agricultural science.

The New Cosmology of Milne

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There are mainly three facts of observational astronomy which all modern cosmological theories attempt to explain. The system of the galaxy of stars of the Milky Way of which our sun is a member is now believed to constitute a part of a huge flat spiral nebula. About two to three millions of such nebulae have been discovered in the sky up to the present time, and there is no doubt that many more of them will be visible with more powerful telescopes than those we have at present. With the most powerful telescope of the present time, a hundred-inch reflector at the Mount Wilson Observatory, a distance of about 200 million light-years has been penetrated, a light-year being the distance covered by a ray of light in one year. Within about one-twentieth of this range, which we may call our neighbourhood, fairly reliable estimates of distances are possible. The distribution of nebulae here is roughly uniform. The average mutual distance between two spiral nebulae in this region is about a million light-years, which is nearly thirty to fifty times the average dimension of a nebula. Thus in our neighbourhood matter appears to be rather thickly distributed in space, and the density of matter is more or less uniform. The uniformity of the distribution of matter in our neighbourhood is believed by astronomers to be typical of the entire space, as there is a general aversion to the supposition that our part of the Universe has some speciality not possessed by any other part. An examination of the spectra of the distant spiral nebulae shows red displacement of their characteristic lines, from which it is inferred that all these nebulae are receding from our own galaxy. The velocities of recession are high, ranging from several hundred to nineteen thousand kilometres per second (See SCIENCE AND CULTURE, Nov., p. 354). In recent years, the statistical study of nearly three hundred nebulae has shown that a definite correlation exists between the velocities of the nebulae and their distances; in fact, the velocities are proportional to the distances. More precisely, the velocity of a receding nebula is 560 kilometres per second for every distance of one million parsecs, one parsec being about three and a quarter light-years.

Cosmic rays are a very mysterious type of phenomenon, which are now being studied very earnestly by physicists all over the world. They consist of rays of very powerful penetrating power, coming from some extra-terrestrial sources which have not yet been definitely identified. The rays are constituted probably of very fast moving (almost with the velocity of light) fundamental particles, such as electrons, positrons, and other material particles (about the exact nature of which researches are still going on), and possibly of some very penetrating electromagnetic radiations. It is believed by many physicists that these rays are destined to play a fundamental role in the theory of the ultimate constitution of matter. In fact, the opinion has often been expressed that they are the constituents of the workshop in which the inner cores of material atoms are manufactured. It is felt that a theory of the Universe cannot leave such a material of fundamental importance out of consideration. Milne's cosmology finds a place for this phenomenon in the cycles which, according to his theory, material particles in motion in space are destined to complete.

Milne's cosmology primarily deals with the construction of certain types of motions of material particles in space (the motions not being, *a priori*, governed by the wellknown dynamical laws) in which the cosmical motions, described in the previous paragraphs, find a representation. The simplest type of this motion, called hydrodynamical motion, consists of streams of particles moving without collision outwards along radii vectors drawn from the observer (who surveys the system). The particles have uniform motion, though the velocities of different particles, in general, measured by the observer at the same instant are different. The system is

assumed to possess perfect symmetry with respect to the centre which is the position of the observer. This hypothetical motion of particles does not conform to the ordinary dynamical laws, but is governed by what is called by Milne Einstein's *Cosmological Principle* (or Principle of Equivalence)—the only hypothesis on which Milne's cosmology is built up. The gravitational theory of Einstein in which the properties of space are connected with the dynamical condition of matter filling up that space, on which a relativistic cosmological theory has been built up, is discarded by Milne. His point of view is that for the representation of natural laws the choice of space is a matter of option. Having chosen a particular space, flat or curved, the problem reduces to the discovery of laws suitable for that space. Milne chooses the ordinary Euclidean space, but the motions of matter in that space are restricted only by the Cosmological Principle.

The description of natural phenomena has a meaning only with reference to an observer. In Milne's cosmology every picture has on the background a certain observer who surveys the entire motion of matter in the Universe. In fact, with every particle of matter is associated an observer, and the complex is called a "particle-observer". Every particle-observer is supposed to "construct" his space-time by observation of the material particles around him, simply from his instinctive perception of time. The space-time constructs of two particle-observers in uniform relative motion are connected together by means of Lorentz transformation. This, however, is not an assumption with Milne but is the consequence of the Principle of Equivalence mentioned before. This Principle can be enunciated thus: if A and B are two particle-observers who have an agreed code of measurement of time, and if the totality of A's observations by his own clock on B is the same as that of B's observations by B's own clock on A, the two observers are said to be equivalent, or their observations are said to satisfy Einstein's Cosmological Principle. A more extended form of this Principle, which is also applied, assumes that the totality of observations by A *on the entire system of particles* around him is the same as the totality of observations by any other particle-observer of the system, say B, on the same system. In other words, the two observers give the same description of the system, each in terms of his own time and co-ordinate measurements. That this hypothesis is expected to lead to conclusions quite unlike those obtained from our ordinary dynamical ideas can easily be realized if we simply examine the postulate that "all parts of the Universe are alike or equivalent" from two different points of view. While from the usual standpoint it is taken to mean that the density distribution in space at any instant, for example, with reference to an observer will be given by a constant, from the point of view of Cosmological Principle it will be interpreted with reference to two equivalent observers who would give the same description of density distribution (not necessarily by a constant), each in terms of his own clock and co-ordinate measurements. It can be shown that if two particle-observers in uniform relative motion satisfy the Principle of Equivalence, their space-times are necessarily connected by Lorentz transformation. This plays a fundamental role in the new theory.

Milne has been able to show that it is possible to build at least two systems satisfying Einstein's Cosmological Principle in the restricted or extended form. The hydrodynamical system of which mention has been made above can be constructed thus: Imagine a set of particles in ordinary space moving uniformly with respect to some particle-observer O, with all possible velocities from zero to the velocity of light c. This system will satisfy the Cosmological Principle if, as observed by the particle-observer O, it consists of particles moving uniformly with all possible velocities from zero to c radially outwards. The radial motion should be representable by the simple equation

$$r = Vt, \quad \ldots \quad \ldots \quad (1)$$

where r is the position of a particle with velocity V at time t, all quantities measured by the observer O. This system of particles is central symmetric with respect to O and has the marvellous property that any other particle-observer P will see the system symmetrical about himself, and the particles will all be moving away from him radially outwards according to the law (1), the co-ordinates and the velocities being measured with respect to himself, and t being the time by his own clock. This is indeed a conse-

quence of the system satisfying the Cosmological Principle. The entire system of particles will in this scheme be sorted out in space automatically after a lapse of time according to their velocities, those with greater velocities will be found farther than those with smaller velocities. In fact, it is apparent from (1) that the velocities of the particles will be proportional to their distances, the same as the observed velocity-distance relation of the spiral nebulae.

The variable t occurring in (1) has a wonderful interpretation. It is the time by the clock of the particle-observer O. From (1) it is evident whatever V may be, $r=0$ when $t=0$. Hence the motion described by (1) is such that if we interpolate backwards, we get the result that all particles had been on the particle-observer O at the beginning of time. Milne definitely identifies this instant $t=0$ with the beginning of time or the "Creation" for the observer. There was a definite beginning $t=0$ for *every* particle-observer of the system, when the entire system of material particles was close to him. Assuming the observed velocities of the spiral nebulae, namely about 500 km/sec per million parsecs, to be their real velocities, Milne calculates from (1) the time of the present terrestrial observer to be about two thousand million years, so that for us the time of "Creation" dates back to this age.

The hydrodynamical system possesses a completely symmetrical structure in every way. Every particle-observer will consider himself to be at the centre of the entire system, and will describe the system exactly in the same terms as any other particle-observer. There is nothing like the centre of gravity of the system, a preferential point, or an axis of symmetry. But the system of any observer O will be limited. He can observe all particles within the sphere with himself as centre and radius ct, where t is the age of the system in his reckoning. The radius of this sphere increases with the speed of light. Particles lying outside this sphere at any time will ever remain unobservable to him, and are physically of no consequence. Though this observable domain of any particle-observer is finite, for him it will have the property of infinite space, since the boundary of this space, namely $r=ct$, will be inaccessible by any other hypothetical observer travelling towards it with a speed less than that of light.

If any particle-observer counts the number of particles in the system in a small volume, say within $dxdydz$, he will find it to be $n\,dxdydz$, where

$$n=\frac{Bt}{c^3(t^2-r^2/c^2)^2}, \tag{2}$$

where B is a constant, r the distance of the small volume element from the observer, c the velocity of light and t the time by the observer's clock (since creation). The local density of the particles which can be obtained from (2) by making r small is B/c^3t^3. This is constant spatially so that the distribution of matter is locally homogeneous. The deviation from the above constant value of density which can be found by expanding (2) is of the order $(r/ct)^2$, a small quantity (when we remember the dimension of t), unless r is nearly as great as the radius of the bounding sphere $r=ct$. The particle density will increase enormously very near this boundary and will be theoretically infinite on it. But Milne's system excludes the particles *exactly* on the boundary and resembles what mathematicians call an 'open set' of points. If however the particles are assumed to be luminous, it was shown by Milne that in spite of their very large density near the boundary, their total illumination as observed by O instead of being infinite is finite. This is in fact due to their large recession velocities almost equal to the velocity of light near the boundary which makes the luminosity of any single object vanishingly small. This result, according to Milne, is in agreement with the observed darkness of the night sky.

In the construction of Milne's system no dynamical concepts, such as *mass*, *momentum*, *force*, etc., have been used. His system is the outcome of the study of matter in motion satisfying Einstein's Cosmological Principle. There is no evidence of gravitation in the system as the motion is entirely unaccelerated. But gravitation can be introduced in the following manner: The particles whose motions are given by (1) will be called fundamental particles. Suppose at any epoch a particle is projected from any fundamental particle P with any velocity V, different from the velocity of P. Imagine similar particles projected from every fundamental particle with all velocities and in all possible directions. If it is assumed that this entire system satisfies the Cosmological Principle in the restricted sense, such that any

two fundamental observers describe the system in the same manner, Milne is able to show that the projected particles will have accelerations given by the equations

$$\frac{dV}{dt} = (r - Vt)\,\frac{Y}{X}\,G(\xi), \qquad (3)$$

where $X = t^2 - r^2/c^2$, $Y = 1 - V^2/c^2$, $Z = t - (r.V)/c^2$, $\xi = Z^2/XY$, and G is an arbitrary function of its argument ξ. Thus when the original system of fundamental particles (1) is extended by the addition of other particles in the manner stated above, and the entire system satisfies the Cosmological Principle when observed by fundamental observers, these new particles experience an acceleration given by (3). This shows the existence of gravitation in the system. Now $r - Vt$ in the new system gives the system of fundamental particles, since then $dV/dt = 0$. The mathematically arbitrary function G is to be made definite by comparison with observation. If for a moment we apply Newtonian mechanics to the slowly moving particles in the neighbourhood of the observer with the "local" density distribution calculated above as B/c^3t^3, and compare the Newtonian acceleration of a particle with that given by (3), the gravitational constant γ is obtained as

$$\gamma = -\frac{3}{4}\cdot\frac{c^3t}{4\pi mB}\,G\,(1). \qquad (4)$$

In Milne's theory the gravitational constant depends on time. The value of t being enormously large, the gravitational "constant" γ will behave as sensibly constant to an observer at any epoch.

In addition to the hydrodynamical system Milne has built up another more general system called "statistical system" which satisfies the Cosmological Principle in the restricted sense explained above. The gravitational phenomena in this system are, however, given by the same equation (3). Further conclusions will not be different for these two systems.

Milne has considered extensively the path of particles determined by

$$\frac{dr}{dt} = V, \qquad \frac{dV}{dt} = (r - Vt)\frac{Y}{X}\,G\,(\xi). \qquad \dots (5)$$

These paths, technically called trajectories, can be broadly divided into two classes. The first class describes the motions of groups of particles, each group being again constituted of a complex system of particles. The second class describes the motions of the particles within each group. All particles of the system in the experience of any *fundamental observer* O at the time t when traced back on their paths arrive at O at time $t = 0$. The first class of trajectories, mentioned above, consists of (the threefold infinity of) radial paths of the fundamental particles moving with uniform velocities. These particles Milne identifies with the mean centres of the spiral nebulae. The fundamental particles, as we have seen before, all move outwards and satisfy the velocity-distance relation of the spiral nebulae. The second class of trajectories represents (another threefold infinity of) particles which surround any mean centre of a nebula, say P, in all directions. If the mean centre has the velocity V, this satellite system consists of all particles which together with P were projected from O at time $t = 0$ by O's clock with velocity V. These latter generally crowd round P in great density, and relative to P have slow outward *radial* velocities with accelerations. Milne identifies this group with the stars, star-clusters, etc., forming the gravitating system of a spiral nebula. Any accelerated particle Q of the second group of paths with velocity V will, in the experience of O as well as of P, be falling towards a centre which is identical with that *fundamental particle* (centre of another nebula) which has the velocity equal to V at that instant, say Qc. In P's as well as O's reckoning this point Qc will appear at this moment to be the gravitational centre of the particle Q. But this gravitational centre is not a fixed particle. Since Q is accelerated, its velocity will be changing with time, and hence its gravitational centre will also be changing from one fundamental particle to another. To the observer O the path of Q is a curve of pursuit always falling towards its gravitational centre Qc. But Q will never catch up Qc; on the other hand the distance between them will increase with time. Milne interprets the outward accelerated motion of Q relative to P to represent the dispersion of the nebula (whose centre is P). The course of evolution for the nebulae thus means greater and greater dispersion with time.

We have seen that an accelerated particle, *as observed by O*, describes a curve of pursuit moving always towards a gravitational centre which is shifting from one fundamental particle (centre of nebula) to another. Milne has been able to prove that in a

finite time the accelerated particle attains the velocity of light. After that, according to Milne, it will decelerate gradually, and lose its motion till finally, after an infinite span of time, it will come to acquire a limiting constant velocity, say V_0. Thus ultimately it will accompany the nebula whose centre will have the uniform velocity V_0. From this is to be concluded that in every part of space, at every instant of time, there will be found fast moving material particles with velocities very close to the velocity of light. Milne would identify these with cosmic radiation. Secondly, a suggestion is further made that the decelerated particles which ultimately settle down quiescently in the neighbourhood of another system are the dark clouds of dust-like matter which we suspect to be present in our galaxy and whose presence is clearly shown in the photographs of many distant spiral nebulae.

Alcohol from Molasses

Successful experiments have been made in Burma in the production of alcohol from molasses, and this success has been achieved by the use of sulphuric and sulphate of ammonia, adding the former to the extent of 1 in 1,000 by volume and the latter to the extent of 1 in 1,000 by weight. The molasses is dissolved in a minimum of hot water and it has proved advisable to add the sulphuric acid to the hot solution. After standing overnight the solution is pumped into the vats containing the required quantity of cold water to dilute it to the correct concentration which is determined by its specific gravity. Sulphate of ammonia is added while pumping in the molasses and yeast is added immediately. It is important to keep the temperature as low as possible to prevent losses due to several causes, among which the chief seems to be the weakening of the yeast. In actual practice it has proved possible to obtain yields of more than 100 London proof gallons per ton of molasses on the large scale, using the methods described above. It may be noted that in India a yield of 80 gal. of London proof spirit is considered a good result as in many cases the yields may be only about 60 gal. of proof spirit per ton of molasses.

As the use of sulphuric acid is not without danger it is hoped shortly to carry out similar tests on the large scale using sodium or ammonium fluorides instead of sulphuric acid. Preliminary tests have already been made, but the amounts of fluoride available in India have been too small to be effective. It is hoped that fluorides will be as effective as sulphuric acid, and, although the original cost of fluorides is fairly high, freight is relatively low and it may prove commercially advantageous to use fluorides instead of sulphuric acid.

Experiments were also made for the manufacture of starch from broken rice and sweet potato. In the case of rice, the starch was obtained by the usual process with 1.5 per cent caustic soda and the gluten was precipitated from the alkaline liquid after contact for 56 hours with sulphuric acid. The purity of the starch was 96.16 per cent and the sample was of very good quality. The gluten should be readily saleable as it contains over 40 per cent protein. It is considered that starch manufacture from broken rice offers distinct possibilities. The preparation of good quality starch from sweet potatoes is not a simple operation in the laboratory if sedimentation only is relied upon. The potatoes are fibrous and grinding is difficult, and fine grinding to give high yields of starch results in much colloidal material being obtained and this is difficult to separate from the starch. Further attempts are being made by using alkaline sulphides.

—*The Chemical Age, Feb. 1, 1936.*

Biological Oxidations

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In order to perform the essential functions of life, like keeping oneself warm, digestion, movement, and reproduction, an organism needs energy and this energy it obtains from the oxidation of organic substances present in the cells. A living being obtains these substances from the digested and assimilated food materials. The end products of these oxidations are carbon dioxide and water. In considering the mechanism of the oxidative breakdown of the organic substances (called metabolites) in the body, the essential problem is to determine how stable substances like succinic acid, fatty acids, and glucose, which in the laboratory are resistant to oxygen and some of which are not attacked by powerful oxidizing agents like nitric acid, are so easily oxidized by oxygen inside the body. Of course these oxidations in the tissues go on in the presence of colloidal catalysts sensitive to high temperatures called *enzymes*. The enzymes, therefore, activate one of the two factors necessary for biological oxidations, either the oxygen which is rendered more reactive or the metabolite. The first view has been put forth by Warburg while Wieland has maintained that the enzyme which has been called dehydrogenase activates the metabolite in such a way that the hydrogen atoms in the molecule are rendered labile and combine readily with the oxygen. For a long time a bitter controversy went on between the two schools of thought which stimulated much work until the recent work of Keilin incorporated the two theories into one comprehensive scheme of mechanism of respiration.

Warburg's Theory

Warburg maintained that in biological oxidations, oxygen was activated by the 'respiratory enzyme' (*'Atmungs-ferment'*) which is present in all cells and tissues and which owes its activity to the presence of iron. This iron-containing respiratory enzyme is to be carefully differentiated from the haemoglobin of the red-blood corpuscles, which also contains iron and which simply serves to carry the oxygen to the different tissues without activating it in the least. Warburg gained some insight into the nature of his '*atmungs-ferment*' by studying the respiration of sea-urchin eggs, which was found to be almost completely inhibited by very low concentrations of hydrocyanic acid. The inhibiting action of HCN was explained by Warburg as being due to its combination with iron in the enzyme whereby the latter could not be alternately oxidized and reduced and was thus rendered inactive. Then Warburg carried out some model experiments with charcoal. Charcoal made out of blood which contained active iron could oxidize oxalic acid, cysteine, cystin, tyrosine, and many other substances, and this oxidation, like the respiration of sea-urchin eggs, was inhibited by HCN. Pure charcoal from canesugar could not bring about these oxidations and this charcoal was rendered catalytically active, not by the addition of iron salts alone to the sugar before heating but also of nitrogenous materials besides the iron salt. Warburg, theretore, concluded that the iron in the respiratory ferment was present as a nitrogenous complex. Further insight into the nature of the complex was gained by studying the inhibiting action of carbon monoxide on the respiratory enzyme of the yeast cells. It is well known that CO combines with the haemoglobin and thus prevents the transport of oxygen. CO possesses a similar but lesser affinity for the respiratory enzyme. Thus HCN poisoning is due to the cellular respiration being stopped, although sufficient oxygen is available while in CO poisoning there is lack of oxygen in cells because of the action on haemoglobin although at ordinary pressures of CO the respiratory enzyme is not completely inactivated.

The concentration of the ferment iron in the living tissues is very small; it is of the order of 1 gm. in 10 million gram cell-substance. It is, therefore,

impossible to measure its absorption spectrum: directly. Carboxy-haemoglobin and CO-haemochromogen complexes are light-sensitive, and Warburg found that the respiration of yeast in presence of CO was also increased on illumination. It was thus evident that the CO-respiratory-ferment complex was also dissociated by light. Using monochromatic light of different wavelengths and of a given intensity, Warburg measured the time required for the half of the CO-respiratory-ferment complex to be dissociated and thereby he could calculate the absorption coefficient of the complex for the different wavelengths employed. The curve thus obtained for the absorption spectrum of the CO-ferment complex closely resembled that of CO-haematins. Warburg concluded that the nitrogenous iron compound of the respiratory ferment was chemically related to a haematin which contains four pyrrolic rings and iron, and this haematin was associated with a protein or a base as a haemochromogen in which the iron is contained in the reduced state. This ferrous iron of the ferments is, according to Warburg, alternately oxidized by oxygen and reduced by metabolites. While the first process can be easily reproduced in the laboratory, the second process, *viz*. the reduction of trivalent iron by the organic substances of the cell is very difficult to attain.

Warburg, therefore, in his lecture at Stockholm in December, 1931, at the time of receiving the Nobel Prize, has been compelled to recognize an activation of the metabolite being necessary as was previously advocated by Wieland. It is also difficult to explain on the basis of Warburg's theory why substances like oxalic acid, phosphorous, arsenic which are easily oxidized *in vitro* are immune to oxidation in the living organism while other substances, such as fatty acids, whose oxidation in the laboratory can only be achieved by powerful oxydizing agents, are oxidized with the greatest ease in the organism. While Warburg's theory might truly represent the state of affairs at the oxygen end of the respiration it does not explain the selective action nor does it focus any attention on the intermediate stages through which a metabolite passes before it is completely burnt. Thus the consideration of the means of oxidation is transferred to the substrate and the dehydrogenation theory of Wieland has rendered a great service to science by correlating the oxidation of substances of most varied nature under one comprehensive scheme.

Wieland's Theory

Wieland's dehydrogenation theory is based on some model experiments with finely divided palladium and platinum as catalysts. Wieland pointed out that in the catalytically promoted combination of hydrogen and oxygen, the influence of the metal is directed towards the hydrogen which is activated and is then capable of being added to the acceptor oxygen. Hydrogen peroxide can be identified as the initial product. If an aqueous solution of acetaldehyde is shaken with a suspension of palladium black in the absence of air, the palladium is charged with hydrogen and the aldehyde is oxidized to acetic acid. If, however, a reducible substance, like oxygen, methylene blue, or quinone, is also present, the palladium transfers the hydrogen to this acceptor which is reduced to water, leuco-methylene blue, or hydroquinone. Wieland showed that the aldehyde reacts in its hydrated form which loses hydrogen under the influence of the catalyst palladium and the hydrogen then combines with the oxygen or any other suitable acceptor present.

$$CH_3-\underset{\displaystyle OH}{\overset{\displaystyle H}{\overset{|}{\underset{|}{C}}}}-OH + Pd + \text{Acceptor} \longrightarrow CH_3-\underset{\displaystyle OH}{\underset{|}{C}}=O + Pd + \text{Acceptor-}H_2$$

The process of dehydrogenation goes on with absorption while hydrogenation processes go on with evolution of heat. When the energy necessary for the first operation is at least covered by the hydrogenation of a reducible substance or, in other words, the free energy of the oxidation-reduction process is positive, the reducible substance can act as an acceptor of the hydrogen. Measurement of oxidation-reduction potential enables us to say if any particular substance is capable of acting as an acceptor towards a substance which can lose hydrogen under the influence of a catalyst. Wieland maintains that in biological oxidations the substance to be oxidized, called the donator, has its hydrogen activated by an enzyme, called dehydrogenase, and the activated hydrogen then combines with the oxygen which is the acceptor. Consistent with the specificity of enzymes, for the activation of different

donators different dehydrogenases would be necessary. Wieland also showed that in the oxidation of alcohol to acetic acid by acetic acid bacteria, methylene blue or quinone could replace oxygen. With oxygen as the acceptor hydrogen peroxide would be expected to be first formed but this hydrogen peroxide cannot be detected as it is rapidly decomposed by the enzymes catalase and peroxydase which are present in almost all cells. Hydrogen peroxide has been detected in the respiration of catalase-free anaerobic lactic acid bacteria (Bertho). It has also been possible to bind the hydrogen peroxide formed in the oxidation of aldehydes and xanthine by the catalase-free milk dehydrogenase (Schardinger-enzyme) in presence of oxygen by binding the hydrogen peroxide formed by means of the cerium reagent which is converted into cerium peroxide.

Thunberg's work on the oxidizing enzymes in tissues strongly supported the views of Wieland. He developed the well-known Thunberg methylene blue technique in which the oxidation of metabolites is brought about anaerobically, *i. e.* without the intervention of air, by enzymes in presence of methylene blue. The methylene blue accepts the hydrogen of the metabolites and is reduced to the colourless leuco-compound. Thunberg showed that under these conditions a large number of organic substances, like succinic acid, malic acid, etc., which are most likely intermediate products of metabolism, can decolourize the dyestuff in presence of the tissues of freshly killed animals. That different and specific dehydrogenases were involved was shown by the fact that when the tissues were subjected to different treatments they lost the power to oxidize some of the metabolites while retaining the power to oxidize others. It is to be noted that the anaerobic dehydrogenation of succinic acid by the succino-dehydrogenase of the tissues in presence of methylene blue is not inhibited by HCN.

Intensive work has been carried on to investigate the dehydrogenases in simple organisms, like acetic acid bacteria, yeast, and B. coli, in animal tissues and also in milk and plant seed. The bacterial enzymes have been studied in a physiological salt solution of the bacteria whereby the reproduction is stopped and the cells lapse into a quiescent condition. These investigations have revealed that a large number of organic substances can be oxidized by these dehydrogenases, the action of the enzymes being inhibited by narcotics. Hence it appears likely that the action of narcotics may in part be exerted by their inhibiting action upon the dehydrogenase mechanism of the nervous system. The anaerobic dehydrogenation in presence of methylene blue or quinone is hardly affected by HCN while the aerobic (*i. e.* in the presence of air) dehydrogenations are almost invariably strongly inhibited by traces of HCN. A large number of dehydrogenases have been found in animal tissues, *viz.*, an enzyme which dehydrogenates succinic acid to fumaric acid, another which dehydrogenates malic acid to oxalo-acetic acid, and besides, the following dehydrogenases: lactic, citric, alcohol, glycerophosphoric, hexosephosphoric, amino-acid, and glucose dehydrogenases. It appears that the action of some of the dehydrogenases, like the lactic dehydrogenases, requires the presence of a heat stable co-enzyme. The co-enzyme of the lactic dehydrogenase has been obtained as a crystalline picrate and appears to be an adenyl nucleotide and, what is remarkable, the lactic co-enzyme has been found to be capable of replacing the co-enzyme in the alcoholic fermentation of glucose. The tissues also contain an enzyme fumarase which hydrolyses fumaric to malic acid and another enzyme, carboxylase, which can split off carbon dioxide from α-keto acids. We can now, with advantage, trace the successive stages in the oxidation of succinic acid in the tissues.

$$\underset{\text{succinic acid}}{\begin{matrix} CH_2COOH \\ | \\ CH_2COOH \end{matrix}} \xrightarrow[\text{(succino-dehydrogenase)}]{-2H} \underset{\text{fumaric acid}}{\begin{matrix} CHCOOH \\ \| \\ CHCOOH \end{matrix}} \xrightarrow[\text{(fumarase)}]{+ H_2O} \underset{\text{malic acid}}{\begin{matrix} CHOHCOOH \\ | \\ CH_2COOH \end{matrix}} \xrightarrow[\text{(malic dehydrogenase)}]{-2H}$$

$$\longrightarrow \underset{\text{oxaloacetic acid}}{\begin{matrix} COCOOH \\ | \\ CH_2COOH \end{matrix}} \xrightarrow[\text{Carboxylase}]{-CO_2} \underset{\text{pyruvic acid}}{\begin{matrix} COCOOH \\ | \\ CH_3 \end{matrix}}$$

There are now two possibilities in the next stage of break-down. The first possibility is

$$(i)\quad \begin{matrix} COCOOH \\ | \\ CH_3 \end{matrix} \xrightarrow[\text{carboxylase}]{-CO_2} \underset{\text{acetaldehyde}}{CH_3CHO} \xrightarrow{+\ H_2O} \underset{\text{aldehyde hydrate}}{CH_3C\begin{matrix} \nearrow (OH) \\ \searrow (OH) \end{matrix}} \xrightarrow[\text{dehydrogenase}]{-2H} \underset{\text{acetic acid}}{CH_3COOH}$$

and two molecules of acetic acid might in the following manner be dehydrogenated to succinic acid, the production of succinic from pyruvic acid having been shown to occur in moulds and in yeast.

$$\begin{matrix} CH_3COOH \\ \\ CH_3COOH \end{matrix} \xrightarrow{-2H} \begin{matrix} CH_2COOH \\ | \\ CH_2COOH. \end{matrix}$$

(*ii*) The other possible way starting with two molecules of pyruvic acid is as follows

$$\begin{matrix} CH_3COCOOH \\ \\ CH_3COCOOH \end{matrix} \xrightarrow[\text{(dehydrogenase)}]{-2H} \underset{\alpha\alpha' \text{ diketoadipic acid}}{\begin{matrix} CH_2COCOOH \\ | \\ CH_2COCOOH \end{matrix}} \xrightarrow{+\ 2H_2O} \underset{\text{succinic acid}}{\begin{matrix} CH_2COOH \\ | \\ CH_2COOH \end{matrix}} + \underset{\text{formic acid}}{2HCOOH}$$

The formic acid is then dehydrogenated in the tissues to CO_2 and water.

Perfusion experiments of Toennissen have shown that pyruvic acid is converted to succinic and formic acids but not to acetic acid and thus support the second possibility. Succinic acid is thus regenerated and the cycle begins again.

The anaerobic processes in the tissues convert glycogen and other carbohydrates through the intermediate formation of hexosephosphates into lactic acid which is dehydrogenated in the tissues to pyruvic acid. Further, there are evidences to show that succinic acid may be an intermediate product in the break-down of proteins and fats. Thus the oxidative break-down of carbohydrates, proteins, and fats is correlated with pyruvic acid as the intermediate substance common to all the three processes. The discovery of a glucose dehydrogenase, which oxidizes glucose to gluconic acid, in the liver tissues which are very rich in the enzyme, suggests that the oxidation of glucose might also occur in the body in this independent alternative way (Harrison).

The question now arises as to the number of different dehydrogenases. There is ample proof to show that the number is large and that the large number is also essential for the high degree of specialization involved in the life of the cell. But acetic acid bacteria can oxidize a large number of alcohols, the Schardinger enzyme in milk can oxidize a large number of aldehydes while B. Coli can oxidize such a large number of substances that it is difficult to imagine how so many individual enzymes, each with its colloidal carrier and active group, can be accommodated in a single cell of the bacteria. It appears that the dehydrogenases are type specific and not molecule specific. It is, therefore, somewhat remarkable that substances of such different nature such as hypoxanthine and aldehydes are, as has been shown by the workers in the Cambridge Biochemical Laboratory, oxidized by a single dehydrogenase present in milk. Wieland, however, thinks that the xanthine dehydrogenase is different from the Schardinger enzyme that oxidizes the aldehydes.

Not to speak of crystalline preparations, cell-free preparations of hydrogenases are difficult to obtain and the solutions are not very stable. Some insight

into the nature of the active group in the enzymes has been obtained by studying the action of a large number of acidic and basic dyes on dehydrogenases. Both in the case of dehydrogenases in B. Coli (Quastel) and also of milk dehydrogenase (K. P. Basu) only the basic dyes acted as inhibitors and the acidic dyes were without any effect showing that the active group in the enzyme is of acidic nature.

According to the original views of Wieland, with activation of hydrogen the problem was solved, the activated hydrogen being free to react with any acceptor that fulfils the thermodynamic conditions. But all thermodynamically possible reactions do not take place and while the milk dehydrogenase can activate its substrate in such a way that it can use either methylene blue or oxygen as the hydrogen acceptor, almost all the remaining dehydrogenases enable their substrates to reduce methylene blue but not to take up molecular oxygen. Hence the necessity arises of the need of activations of oxygen or the presence of oxidation-reduction systems capable of acting as hydrogen acceptor and of being oxidized either by molecular or activated oxygen.

Keilin discovered the presence of a pigment called cytochrome in most aerobic cells and tissues. The pigment which contains three components, a, b, c, is an iron containing porphyrin (haematin) united with nitrogenous substances and exhibits characteristic spectrum in the reduced state. The reduced cytochrome is capable of being oxidized not directly by molecular oxygen but by oxygen in presence of an enzyme. This enzyme is very widely distributed and has got the property of oxidizing a mixture of p-phenylene-diamine and α naphthol (called the Nadi reagent) to indophenol blue. The enzyme is therefore called indophenol oxidase and is, like the respiratory ferment of Warburg, inhibited in its action by hydrocyanic acid and by CO. The indophenol oxidase which can oxidize reduced cytochrome and cytochrome appear to co-exist in cells, and hence the indophenol oxidase appears to be cytochrome oxidase. There is a rough parallelism between the amount of cytochrome present in a tissue and its rate of metabolism. Keilin argued that cytochrome plays an important part in biological oxidations and serves as the connecting link between the hydrogen-activating and oxygen-activating mechanism of the cell. Cytochrome has the property of reversible oxidation and reduction and can actually be seen to undergo continual oxidation and reduction in living cells. Keilin suggests that in intracellular oxidation the metabolites activated by dehydrogenases become hydrogen donators and undergo oxidation by reducing oxidized cytochrome which acts as hydrogen acceptor. The reduced cytochrome is oxidized by oxygen activated by the indophenol oxidase.

$$\text{Metabolites} \xrightarrow[\text{Dehydrogenase inhibited by narcotics}]{} \text{H active} \longrightarrow \text{cyto-}$$

$$\text{chrome} \leftarrow \underset{\text{active}}{\text{O}} \xleftarrow[\text{Indophenol oxidase inhibited by HCN + CO.}]{} \underset{\text{inactive}}{O_2}$$

The question now arises whether the indophenol oxidase is identical with Warburg's respiratory ferment. The indophenol oxidase, since it is inhibited by HCN, contains iron but is not a haematin derivative. That Warburg's ferment is a haematin compound is not definitely established: the action of light in annulling the CO inhibition of the respiration of the yeast cell might be due to a photosensitive reaction, the light being absorbed by haematin compounds present in yeast and transferred to the CO-respiratory ferment complex.

Hopkin's discovery of the tripeptide glutathione which is almost invariably present in all aerobic tissues and is capable of being present in an oxidized (disulphide) and a reduced (sulphydryl) form raised hopes that it played a very important part in intracellular respiration. While glutathione has been shown to play a marked part in the respiration of liver and of kidney, its role in the respiration of other tissues is doubtful.

Recent experiments have revealed the presence in various cells of oxidation-reduction systems capable of being oxidized by molecular oxygen, the oxygen uptake being uninfluenced by HCN. Warburg and Christian (1932) isolated a yellow pigment from bottom yeast which can act as a hydrogen acceptor towards hexosemonophosphate activated by a dehydrogenase and a co-enzyme. The reduced yellow pigment (which was called "gelbe Ferment" by Warburg) is oxidized by molecular oxygen even in the presence of HCN or CO. The pigment proved to be a flavin associated with a protein and was

effective only in combination. Other flavins, free from protein, have been shown to be capable of being transformed into leuco-forms by several dehydrogenase systems, the leuco-form being oxidized by molecular oxygen. Thus flavins very probably play a part in respiration. It is to be remembered that flavins also show vitamin B_2 activity. Another vitamin, vitamin C (ascorbic acid), is capable of being reversibly oxidized and reduced and may be concerned as a carrier in biological oxidations. Peters has claimed that vitamin B_1 also plays a part in the respiration of tissues. The blue pigment pyocyanine from B. pyocyaneus which behaves as a reversible oxidation-reduction indicator has been shown to play an important role in the respiration of B. pyocyaneus. Many other similar pigments have been obtained.

The residual respiration observed in cells poisoned with HCN is undoubtedly due to substances of the type of the yellow pigment. This raises the question whether the entire normal respiration of tissues is cyanide-sensitive. Dixon (1929), working in Cambridge, studied the respiration of various tissues and came to the conclusion that on an average about 50% of the respiration was cyanide-sensitive. Warburg had the experiments repeated in his laboratory by Alt (1930) and it was found that about 100% of tissue respiration was cyanide-sensitive. A recent repetition of the experiments in Cambridge (1935) has confirmed Alt's results and 90% inhibition has been observed. It thus appears that normal respiration in tissues is due to dehydrogenases and indophenol oxidase (or *Atmungs-ferment*). It is only when the latter is inhibited in its action or is unable to act that substances like flavins and ascorbic acid act as intermediaries.

Determination of Thermal Curves

In metallurgical research it is frequently necessary to obtain particulars of the variation of the temperature of metals and alloys over extended periods. The most direct method is to observe temperatures at equally spaced time intervals. The inverse method of measuring the time intervals over which the temperature changes by equal increments has been found much more convenient in practice, and this procedure merely requires the operation of a recording chronograph when the observed temperature has definite values. The inverse method of obtaining rates of temperature change has hitherto been used in conjunction with a deflection potentiometer for temperature indication. The deflectional potentiometer has been found to have certain disadvantages, the chief of these being the necessity for the manipulation of the potentiometer switches when the limit of the galvanometer deflection is reached. A new type of potentiometer for the plotting of thermal curves has recently been devised at the *National Physical Laboratory*, whereby the null method of measurement is used. The principle underlying the new instrument is that of altering the dial reading of the potentiometer by equal steps of 10 microvolts. The adjustment of the potentiometer is semi-automatic, and is made simultaneously with the operation of the plotting chronograph, whenever the galvanometer indicates a null reading. By this means time intervals corresponding to equal temperature increments are obtained. The duty of the observer is reduced to a minimum, as he has merely to watch the spot of the galvanometer as it creeps towards zero, and to press a key when the zero reading actually occurs. The alteration of the potentiometer reading by remote control results in the spot being again deflected, and the process is repeated. It is intended ultimately to make the equipment fully automatic, by using a photo-electric cell and suitable relays to operate the potentiometer and chronogrph when the reading of the galvanometer is zero.

—*World Power.*

Eighth All-India Oriental Conference, Mysore.

The eighth session of the ALL-INDIA ORIENTAL CONFERENCE met at Mysore on December, 29, 30, and 31, 1935. The CONFERENCE was fairly well attended though delegates from North India were necessarily less numerous than those from the South. There were a few foreign orientalists. Mysore shows an interesting combination of ancient tradition and modern civilization and of learning and art. It was, therefore, in the fitness of things that His Highness the Yuvaraja suggested in his opening address that orientalists of India should pay serious attention to the study of the handicrafts of India. Very interesting specimens of Mysore handicrafts were displayed in the art exhibition organized in connection with the CONFERENCE and in the excellent Chamarajendra Technical Institute. It makes one's heart glad to see in Mysore the continuance of old traditions in art and the fine workmanship of the modern artisans. Without enlightened patronage from the States arts and crafts cannot flourish. Their prosperity in Mysore is due to the abundance of this patronage. Special mention may be made of the sculptures in stone and in metal and working in ivory of Siddhalingaswami, who has supplied a number of drawings to illustrate Dr. P. K. Acharya's edition of the *Manasara*. Want of State patronage, and foreign competition have almost wholly destroyed the old arts and crafts of British India! It is, however, to a Britisher, the late Mr. E. B. Havell, that we largely owe the present attempts in British India for their revival.

The great historian of Madras, Rao Bahadur Dr. S. Krishnaswami Aiyangar, was the General President of the CONFERENCE. In his long presidential address he started with the saying that Indian history began with Alexander's invasions, and showed where matters had improved. He gave a brief survey of the new light that has been recently obtained about Indian history before Alexander, particularly in the Indus basin, and mentioned the usefulness of the recent excavation at Tel-Ashmar in this connection. The extended horizon of the present-day historians of Ancient India was reflected in the long survey he made about recent work on Greater India (both Serindia and Farther India) and the current problems in this field, like the history of the S'ailendras of Sumatra-Java. He laid special emphasis on the fact that the culture of further India was essentially Hindu and underwent decadence when its connection with India ceased. Dr. Aiyangar's rich knowledge of Tamil literature enabled him to throw much useful light on the subject. His interest in South Indian *Bhakti* cults supplied very valuable suggestions about the religious history of these times. In view of the tendency among the present-day reformers to belittle Hinduism and abolish the caste system, he recommended a thorough study of the history of Hindu culture and of the institution of caste. His advice in this matter should not be brushed aside as the utterance of an orthodox Brahmin. It is really necessary that a dispassionate *academic* study should be made of such questions. Dr. Aiyangar lamented over the lack of adequate bibliographical help that prevails in India in oriental studies and suggested that the ORIENTAL CONFERENCE should do something in the matter.

The CONFERENCE was divided into the following sections :—

1.	Veda	*President* :	Dr. Lakshman Sarup of Lahore.
2	Iranian	.	Mr. B. T. Anklesaria of Bombay.
3	Classical Sanskrit	..	Dr. S. K. De of Dacca.
4.	Philosophy and Religion	..	Mr. M. Hiriyanna of Mysore.
5.	History and Geography	..	Dr. Radhakumud Mukerjee of Lucknow.
6.	Archaeology	..	Mr. K. N. Dikshit of the Archaeological Department.
7.	Islamic study	..	Dr. A. H. M. Nizamuddin of Hyderabad.
8.	Prakrits	..	Dr. P. L. Vaidya of Poona.
9.	Ethnology and Folklore	..	Rao Saheb C. Hayavadana Rao of Bangalore.

10. Fine arts and Technical Sciences	..	Prof. S. Suhrawardi of Calcutta.
11. Indian Linguistics	..	Dr. V. S. Sukthankar of Poona.
12. Indo-Aryan Languages	..	Dr. S. K. Chatterji of Calcutta.
13. Dravidian Languages	..	Rao Bahadur R. Narasinha Acharya of Bangalore.
14. Pandit Parishat	..	M. M. Prof. S. Kuppuswami Sastri of Madras.
15. Poet's Congress	..	Thakur Gopal Saran Singh of Rewa.

The sectional president delivered addresses, most of which had been fixed in different hours. It was still difficult for any one man to hear even all the presidential addresses in which he happened to be interested, particularly because the sectional meetings were mostly going on side by side. In the Vedic section, Professor Lakshman Sarup tried to prove that the Mohenjo-daro civilization was post- Rigvedic and said that in view of the recent discovery of a whole host of Vedic commentators from the seventh century A. D. (and even earlier) downwards, we could no longer say that Sayana had no tradition to go by when commenting on the Vedas. Dr. De, though appreciating traditional learning, pleaded for a critical outlook in Sanskrit studies and lamented over the absence of critical editions of our classics.

Dr Mukerji stressed the antiquity and uniqueness of Indian culture and the possibility that has recently appeared of India being the original home of man. Professor Suhrawardy criticized certain tendencies in India about the study of our art and stressed on the study of archaeology. He demanded that art criticism should be objective. He said that our ancient art was not so much bound by tradition as is commonly assumed, nor were the artists always obsessed by religious mysticism. He suggested that the technique of Indian art should be properly investigated. He laid emphasis on the sociological study of art and spoke of race tradition and foreign influence being the two factors that are responsible for the tendencies in any art. Mr. Suhrawardy's suggestion that the art of ancient Iranian nomads might have had some influence on the shaping of Indian art can hardly cause much enthusiasm, as that alleged art of the Iranian nomad is an absolutely unknown thing, at least so far as as Asia is concerned.

Allotment of papers to sections is sometimes a difficult affair and, as usual, there were several wrong assignments. The sections were also not all mutually exclusive and there was a good deal of unnecessary overlapping. It is desirable that proper attention should be paid to this point. Quite a number of valuable papers were contributed by scholars and there were also papers advancing fantastic theories. A machinery had been devised this time for weeding out the valueless papers, but in certain cases the kindliness of sectional committees stood in the way of its operation. We shall draw attention to only a few of the papers, read and discussed in the CONFERENCE without in any way suggesting that these were the only valuable papers. The sections which had the largest number of papers were naturally those of History, Archaeology, Philosophy and Classical Sanskrit. The Iranian, North Indian Languages and Prakrit sections made the poorest show.

Mr. K. Chattopadhyaya of Allahabad tried to show that the usual assumption about the priority of the entire *Rigveda-Samhita* over the remaining Vedic literature was wrong. Dr. H. C. Lefever of Travancore suggested that sin in the *Rigveda-Samhita* was not so much a personal offence against the Gods as a violation of the transcendent cosmic Law (*rita*). Professor A. R. Wadia of Mysore showed that Dualism of Zoroaster, as distinguished from that of later Zoroastrianism, was an ethical one, a dualism involved in all theistic creeds. Kazi Ahmedmian, Akhtar, of Junagadh gave an account of the Arabic poems of Hafiz. Mr. Wahed Hussain of Calcutta had an interesting paper on "Conception of Divinity in Islam and Upanishads." Mr. Dasaratha Sarma of Bikaner, assuming that the *Kumudi-Mahotsava* is a work of the early Gupta period, placed Kalidasa earlier then 340 A.D., as the drama has utilized Kalidasa's writings. The universality of Kalidasa's appeal was illustrated by the attempt of an Andhra scholar, Mr. P. Govindacharyaswami of Vizianagram, to make the great poet a native of Andhrades'a ! Mr. K. A. Subramania Iyer of Lucknow had an in-

teresting paper on a school of grammarians who believed in an *anitya sphota*. Dr. S. K. Belvalkar, now of Benares, had a paper on the pre-Patanjala Yoga, and Mr. H. D. Bhattacharya of Dacca on Yoga Psychology. Mr. P. V. Kane of Bombay presented a very interesting historical treatment of the practices forbidden in the *Smritis* in the Kali Age. Dr. P. M. Modi of Bhavnagar opposed Dr. Belvalkar's well-known view that the Brahmasutras were originally concerned especially with the *Chandogya Upanishad* in a paper, entitled "The Scheme of Brahmasutras I. 1—3: A Rapprochement." Dr. Umesha Mishra of Allahabad pointed out a deficiency in Vachaspati Misra's understanding of scope of the direct perception in the Sankhya system.

Dr. A. S. Altekar of Benares had a paper on the ancient history of Benares, in which he traced the clash of the Vedic religion and the Mahadeva cult of Benares. Mr. Bisheswarnath Reu of Jodhpur suggested a Rashtrakuta origin for the ruling dynasty of Mysore! Mr. N. Kanakarajan of Pudukottah drew on the Tamil Sangam literature for constructing South Indian history of the early centuries of the Christian era. The Local Secretary, Dr. M. H. Krishna, contributed a number of very interesting papers. In one he showed the importance of the Rashtrakuta Empire in the history of the Deccan in the fifth and sixth centuries A. D. In another he tried to show that Sivaji was defeated by the army of the Mysore Raj during his Carnatic campaign. Dr. R. C. Majumdar of Dacca combated Mr. K. P. Jayaswal's view that the king had to take an oath in ancient India on the occasion of his coronation. Mr. V. Raghavendra Rao of Mysore had an interesting paper on the private life of the Peshwas. Mr. V. Ramachandra Diksistar of Madras in his paper, Early History of Jainism in South India, "discounted the tradition about the southern migration of Bhadrabahu and Chandragupta. Dr. H. C. Raychaudhuri of Calcutta tried to show that there was some truth in the claim of the southern conquest made by the early Pala kings of Bengal. Mr. N. Anantharangachar of Mysore presented a paper on "Some Archaeological Notes from a tour in the southern portion of the Raichur District" in which he appealed to the Nizam's Government to pay proper attention to the rich archaeological materials available in the State. Dr. M. H. Krishna had a paper also on the "Prehistoric Pictographs from South India," in which he traced their connections with Mohenjodaro signs on the one hand and Brahmi letters on the other. Rai Saheb Manoranjan Ghosh of Patna, among other papers, presented one on some new finds of Punch-marked Coins in Patna. Mr. K. Narayana Iyengar of Chitaldrug had a paper on the pre-historic remains in South Hyderabad and North Mysore. Prof. K. R. Pisharoti of the Annamalai University tried to prove that the Mandasore inscription of Vatsabhatti referred to the repair of the temple in 966 A. D. and not in the time of Kumargupta I.

Dr. Krishna in a paper on "Some Curious Ways of Disposing of the Dead in Mysore", pointed out that persons dying of certain diseases were disposed of by stones or water or exposure, because it was believed that the Earth would not be fruitful if such corpses were buried within her. Mr. B. S. Krishnaswami Iyengar of Mysore had an interesting paper on the "Karaga" festival of the Tigalas of Mysore. Mr. A. A. Krishnaswami Ayyangar of Mysore presented a paper on the Bakhshali Manuscript in which he pointed out some mistakes of Mr. G. R. Kaye and another on *Chakravala* method of Bhaskaracharya. Mr. M. Mukundaraja read a very interesting paper on the Kathakali of Malabar and Mr. L. Narasimhachar on the Bhagavata plays of Mysore. Another interesting paper was Professor Pisharoti's on "Dohada or the Woman and Tree Motif in Indian Art". Mr. S. P. Chaturvedi of Nagpur showed that the expression, *devanam priya* ("beloved of the gods"), did not bear a bad connotation up to the seventh century A. D. Dr. C. Narayana Rao emphasized the need of a comparative study of verbal roots in Dravidian, Sanskrit, Prakrit, and Modern Aryan languages of India. Dr. Siddheshwar Varma of Jammu pointed out some new Sanskrit verbs in Kshiraswamin's commentary on the Amarakosha. Dr. S. K. Chatterji of Calcutta had another sheaf of comparisons between Indo-Aryan and Austric. Mr. Hariharanath Tandan of Agra had a paper on the accent in Hindi. Mr. Priyaranjan Sen of Calcutta traced the efforts made by the College of Fort William in Calcutta for Hindi. Dr. Chatterji pleaded for the recognition and propagation of the simplified Hindi, spoken in other provinces by speakers whose mother tongue was not Hindi. He

wanted that the greatest common measure of the Bazaar Hindi of non-Hindi areas should be taken to fix the minimum of grammar required in this popular language, which should be called *Loka-bhasha* or *Am Hindustani*. It is thus alone, he contended, that Hindi could be popularized throughout India.

Besides the reading and discussion of papers the CONFERENCE had arranged a number of lantern lectures. Mr. K. N. Dikshit, the Deputy Director-General of Archaeology, gave a very clear account of the Indus civilization in which, among other things, he emphasized the great importance played by ablutions in the life of these people, which can be paralleled from later-day Hinduism. Dr. Lakshman Sarup gave an interesting account of India's contribution to world culture. Mr. V. R. Karandikar of the Narmada Valley Research Society showed on the screen the rich archaeological finds discovered by his Society in a limited area within a very short period of time. This enthusiastic Society deserves every encouragement in its efforts and is expected to throw light on several obscure problems of ancient history. But it is necessary that the Society should secure the services of trained archaeologists and scientifically minded historians. It is unfortunate hat since the discovery of the Indus civilization uncritical people in different parts of India are "discovering" equally ancient relics in what are obviously objects of much later age. We shall not be able to understand our past history correctly if we do not become objective in our outlook. Prof. Kataki, a member of the Kamarupa Anusandhan Samiti, showed on the screen some of its important archaeological discoveries. There was also a demonstration of yogic postures given by Mr. T. Krishnamacharya and his pupil.

The CONFERENCE programme of entertainments was rich and varied. There were representations of some scenes from Sanskrit drama. There were also vocal music, demonstration of the Veena, Sanskrit songs sung with the appropriate gesture marionette show, and classical Indian dance of the Tanjore School. A party from Cochin gave a display of a *Kathakali* (Karala dance with gestures) on the story of Rukmangada and the Ekadashi Vow. All this not only entertained but supplied interesting materials to the serious student of ancient Indian *natya* in its widest sense. The South has not only still preserved many old traditions that have died out in the North but have also introduced modifications. So, for a full understanding of the ancient Indian drama and dancing, the study of the ancient texts has to be combined with that of the living traditions in different parts of the country and the remains of archaeology.

The Council of the ORIENTAL CONFERENCE passed a resolution requesting the archaeological Department of the Government of India to open again its exploration section to give training in archaeology to individuals deputed by universities and other bodies in India and to reinstitute the old system of archaeological scholarships.

Besides the ORIENTAL CONFERENCE, two other organizations held their meetings in this connexion: the Numismatic Society of India, which celebrated its Jubilee, and the Linguistic Society of India. Mr. K. P. Jayaswal, President of the Numismatic Society for the year, delivered his interesting address with lantern slides.

The CONFERENCE had arranged for an excursion to Seringapatam, Somanathpur, Cauvery Falls, and Sivasamudram Power Station and another to Sravanbelagola, Belur, and Halebid after the sessions were over. This CONFERENCE had a very crowded programme of instructive matter. One only wishes that there were a few more opportunities given to scholars for informal meetings where they could have discussed their own problems with other scholars.

The CONFERENCE will meet next (in 1937) at Trivandrum. This is an advantage for North Indian scholars, for this will give them an opportunity for seeing the South further. Our ancient history has been too much of a North-Indian affair. The South has been very much neglected, though its contribution to the cultural history of the North has been very great. It is high time that North Indian scholars should turn their attention to the study of the South.

K. C.

Book Review

Science and the Human Temperament—*By Erwin Schroedinger. Published by George Allen & Unwin Ltd., London, 1935 ; price 7s. 6d.*

The fundamental conceptions underlying the physical interpretation of the material world have undergone remarkable changes within the last decade: cherished and traditional habits of thinking are now out of vogue, and the classical beliefs in the elementary and universal laws of nature are now replaced by faith in statistics and the principle of indeterminacy.

The author of this little book shares with Heisenberg and Dirac the distinction of having set up 'the new fashion.' His views regarding the philosophical implications of this change of scientific attitude are therefore of special interest to all serious students. Like many other eminent scientists, he has endeavoured in these essays to reconcile the apparent conflict of the older and the new ideas. An essential step towards the true solution of the dilemma will be, according to him, to realize that like painting, literature or music, science also is essentially a subjective way of apprehending reality and is therefore coloured and conditioned by the cultural environments of the day. Though scientists endeavour to bar out all personal and temporal factors out of their ultimate statements of results, it should not be forgotten that the actual experiments on which the sciences are based are largely the results of selection out of a vastly more numerous possible sets. These selections are influenced at any moment by "circumstances that are other than purely scientific." Our present scientific policy and mode of thought are immediately dependent on the data at our disposal. These again are the outcome of former selections, and if this chain be followed through an indefinite series of links, we should finally come to the first conscious attempts of the primitive man 'to understand and form a logical mental picture of the world around him.'

The biological and cultural environments do therefore condition the scientific theories. There is no such thing as pure objectivism, or absolute truth, even in science. It is reasonable, therefore, to take up a relativistic attitude and to assert that we can with equal justice "derive chance from law or law from chance, whichever we prefer."

Towards the uncertainty principle and the wave theory, Schrödinger's attitude is similar: One is free to believe "either (i) that matter has really a wave structure and the uncertainty principle is an immediate consequence, or (ii) that the uncertainty principle is the more fundamental conception, and the wave theory is an auxiliary construction for grasping and representing the principle."

Our inherited custom of making conceptual models and detailed images has led us to apparent contradictions whenever we have tried to visualize the structure of matter; so either "one must beware of making models or pictures," or if this solution does not satisfy one, one must be reconciled to leaving large gaps in one's visualization scheme of the physical universe, and thus following the prevalent fashion of "Sachlichkeit" omit all useless decorations in the physical theories, which remain always beyond the domain of observation.

S. N. B.

Physical Principles and Applications of Magneto-Chemistry—*By Prof. S. S. Bhatnagar & Dr. K. N. Mathur. Published by Macmillan & Co., London; pp. viii + 375: price 21s.*

Inter-relation between the structure and the magnetic properties of molecules is a very intimate one, and criteria presented by the latter have always to be satisfied. With the better understanding that we possess now of magnetic phenomena, particularly in the fields of dia- and paramagnetism, a study of magnetic properties is coming everyday more into prominence in connection with the elucidation of molecular structure. Magnetochemistry has reached a stage where a review of its achievements and a statement of the associated problems will be very welcome.

This book by Prof. Bhatnagar and Dr. Mathur is one which has primarily this end in view, and is to

be considered the more welcome as it happens, as far as the reviewer is aware, to be the first book in English on the subject. The work of the book is further enhanced by the competency which the authors possess by reason of their extensive work to speak on the subject with which this volume is concerned.

Following a brief historical account of the earlier developments in magnetism the authors presented the fundamental ideas and definitions which are followed by a rather detailed account of the methods of production and measurement of magnetic fields and of susceptibility. In Chap. IV begins the study of the subject proper, where the magnetic properties of substances are presented in order of increasing complexity of structure, much space being devoted to Pascal's classical works. The next three chapters develop the modern theories of the magnetic properties of inert gases, ions, and diatomic molecules, the first of the three forming an introduction to spectroscopy and atomic structure. Chap. VIII on "Ferromagnetism" shows how incomplete our knowledge is of this branch of magnetism, which, though important for industry, is much less connected with our subject. The next chapter on "Magnetism and Valency" is the central theme of the subject of magnetochemistry, and gives an account of the various theories of valency and of the relation between valency and magnetic properties of ions and molecules including co-ordination compounds. The importance of the various magnetic effects in relation to problems of molecular structure and constitution is recognized, and an account of the optical and other effects is given in the next two chapters, more stress being naturally laid on the Faraday, Cotton-Mouton, and Hall Effects. Chap. XII on "Magnecrystallic action" shows how such studies can supplement X-ray data regarding orientation of molecular groups in crystals and includes much of recent developments. The penultimate chapter deals with the interesting question of the influence of magnetic fields on chemical reactions, though no conclusion is reached. The last chapter gives a description of miscellaneous uses of magnetic properties in physicochemical investigations. In an epilogue a number of outstanding problems in magnetism are mentioned.

The book presents on the whole an enjoyable reading and being shorn of mathematical details and intricacies will be welcome to many who are interested in the experimental side only. Workers will be refreshed to find in the book descriptions of a greater variety of methods for measuring susceptibility than given in other text books on the subject.

There are some minor defects and errors which, we hope, will be corrected in the next edition, *e.g.* UO_3SO_4 on p. 69, Tl^{++} on p. 113, 'Becker' on p. 122, appear as misprints. $K_4Fe(CN)_6$ has a moment of one Bohr magneton and should not be included in the list of salts with paramagnetism independent of temperature (p. 157). A book which assumes on the part of the reader a knowledge of the outlines, though the barest, of wavemechanics and spectroscopy need not add a clause to explain 'periodic table' as is done in p. 58. The hunting for empiric relationships between susceptibilities of metals and their atomic number is a bit out of date and the space devoted to it might have with better profit been given to interpretations on the basis of free-electron paramagnetism, the success of which has rather been ignored. The omission of the Weiss Foëx magnetic balance in Chapter IV is noticeable. To do justice to the title of the book the authors would have done well to confine themselves more to the central theme, include the results of more recent works on magnetochemistry and cut out much of non-essential details. There are occasional unprecise statements. The one occurring at the bottom of p. 206 and that at top of the next require rectification.

D. P. Ray Chaudhuri.

The Restless Universe—*By Prof. Max Born: authorized translation by W. M. Deans. Published by Blackie & Sons Ltd., London and Glasgow: pp. 278 with eight plates and seven mutoscopic pictures, 1935; price 8s. 6d.*

Prof. Max Born has been one of the most distinguished leaders of modern physics, and a popular account coming from his pen of the recent fundamental investigations in atomic and nuclear physics is indeed very welcome.

The book opens with a chapter on the 'air and its relatives.' 'It is odd to think that there is word for some thing which, strictly speaking, does not exist, namely *rest*" -with these words the first chapter begins and we are then introduced to the restless

and chaotic motion of the air molecules and how they become more restless with increasing temperature. From this chaotic molecular motion we pass on to organized motion, *i.e.* molecular beams, and are then told how the size and the number of molecules can be estimated by making use of the beams. This is followed by an account of Brownian motion and a neat exposition of its application to the theory of light scattering in gases.

The second chapter is on ions and electrons. We are first introduced to the atom of electricity in electrolytic conduction. We then pass on to electrical discharge in gases and the determination of the charge and mass of the electron. The question of the origin of mass is then taken up. The electromagnetic theory of mass, the equivalence of mass and energy as brought by the theory of relativity, the self energy of the electron, these are all briefly touched upon and followed by a reference to the author's own contributions in this direction.

The third chapter on waves and particles will probably, to a lay reader, appear the most interesting one. The two aspects, *i.e.* the particle aspect and the wave aspect of matter and radiation, have been described and their *complimentarity* is emphasized. On page 132 we are told as to how matrices first entered quantum physics. "You may wonder how this came about. A student occasionally goes to lectures about abstruse subjects just for the fun and speedily forgets all about them. This is what happened to me with a lecture on higher algebra, of which I recollected little more than the word "matrix" and a few simple theorems about these matrices. But that sufficed. A little playing with Heisenberg's formula showed the connection. Then it was an easy matter to refresh my memory and apply the results." We are quite sure that the above will be a source of inspiration to many young physicists.

On page 117 there is an obvious slip when Prof. Born attributes to the great founder of the quantum theory (Max Planck) the performance of extremely careful experiments on black body radiation. As a matter of fact, Planck never performed any experiment in life, except one on the perviousness of heated platinum to hydrogen.

The electronic structure of matter is dealt with in the next chapter. The wavemechanical interpretation of quantum numbers as nodal surfaces is illustrated by diagrams. X-ray spectra, the spin of the electron, and Pauli's exclusion principle have all been discussed and it has been shown how Pauli's exclusion principle offers a simple explanation of the Periodic system.

The problem of the nucleus forms the subject matter of the last chapter. The law of radioactive disintegration followed by its wave-mechanical explanation as to how α particles steal through potential barriers is discussed. The deuteron, the neutron, the positron, the cosmic rays, the birth of matter (electrofission) are all vividly described.

Prof. Born ends with "The Printer's devil once played me the trick of changing 'nuclear physics' into 'unclear physics.' He was not far wrong." The study of nuclear physics is still in its infancy and there are many difficulties which remain as yet unsolved. The nuclear phenomena do not quite fit in the framework of quantum mechanics that has been developed so far.

A characteristic and novel feature of the book is the seven mutoscopic films which in their working are similar to many Japanese toys in the market. The second film on Stern's experiment on the measurement of molecular velocities is particularly good and depicts the motion vividly. The fourth film appears rather complicated.

When the reader has gone through the book, it may appear to him that the title of the book was a little misleading for he finds here no mention of the restlessness of our universe and other island universes (spiral nebulae) which form the metagalaxy. Here we no doubt learn of restlessness but it is of the microcosmos (Prof. Born's book may perhaps more aptly be styled 'the restlessatom'). The macrocosmos is left untouched and the curious reader may turn for it to the fascinating works of Jeans and Eddington. This also incidentally reminds us of the difference in the writings of Eddington and Born in that Eddington writes with a somewhat philosophic background and his works are thus more fascinating to the general reader. But to anyone having a knowledge of elementary physics and a de-

sire to know the really far-reaching discoveries in theoretical and experimental physics, the present book can be unhesitatingly recommended.

D. S. K. & R. N. R.

Herdmania (the Monascidian of the Indian Seas)—*By Dr. S. M. Das. (The Indian Zoological Memoirs on Indian Animal Types, edited by Dr. K. N. Bahl, No. 5) pp. ix-103, with 3 plates and 59 text figures. Published by Lucknow Publishing House, January 1937; price Rs. 2.*

This zoological memoir fulfils a great need for the study of an Indian type of the important class Tunicata, studied every year in laboratories of Indian universities. It is well illustrated, written in a clear manner, and fully maintains the standard set up in the previous memoirs. It gives not only the description of the anatomy and practical directions for its dissection but it also contains an up-to-date classification of the group with bionomics and distribution of the genus *Herdmania*, which is cosmopolitan in its distribution and has a fairly large number of species reported from almost all the seas except the Arctic. There is a great difference between the monascidian fauna of the Indian seas and that of the European seas. The European forms belong to the family, Ascidiidae; whereas the Indian forms belong mainly to the Tethyidae (Cynthiidae) of which *Herdmania* is the chief representative. The morphology of this genus forms the most valuable part of the book and is eminently suited to the needs of students. The body consists of two parts, the body proper which stands in water and the foot which lies imbedded in the sea bottom. The pharynx is produced internally into a number of broad longitudinal folds which project into its cavity and, being richly supplied with blood vessels, permit a large surface to come in contact with water. The enormous development of the pharynx for respiration and food ingestion is greatly responsible for the high degree of development of the blood vascular system of monascidians. The test also serves as an accessory respiratory organ being supplied with special blood vessels. The coloured plate figure 49 gives the entire vascular system; the course of circulation is also represented diagrammatically on page 80. The knowledge of the physiology of digestion in Tunicates which is ordinarily not available to students of zoology is incorporated. The recent work of Yonge (1925) who worked out the digestion and assimilation in the gut of *Ciona intestinalis*, which belongs to the group that do not possess a well defined liver and that of Berrill (1929) on the digestion *Tethyum pyriforme*, belonging to the same family as *Herdmania* possessing a well defined liver are important contributions. Whether the liver of Tunicates is homologous to that of vertebrates is not decisively proved. It is, however, certain that ferments are secreted mainly by the liver which pours a fluid into the stomach, while the pyloric gland, probably pancreatic in nature, serves as an accessory organ of digestion. It is probable that all ascidians with a distinct liver store carbohydrates in the form of starch, while those with no liver store it in the form of glycogen.

H. R. Mehra.

Radio Research in Australia

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The importance of carrying on *co-operative research work* in radio is now well recognized by all the nations of the world, since the success of the radio communication depends upon the electrical properties of the soil as well as of the atmosphere between the transmitting and receiving stations. But experiments for such surveys over wide areas cannot be undertaken by a single individual or institution. It can be done only by an organized body under state control.

Great Britain, Japan, Soviet Russia, and other western countries have all instituted their radio research boards, while in the United States of America the same type of work is carried out by the National Bureau of Standards. It is very encouraging to find that recently another member of the British Empire, *viz.*, the Commonwealth of Australia, has also set up a Radio Research Board under the Council for Scientific and Industrial Research. So far eight reports, embodying the scientific work done by the Board, have been published. The material contained in these reports is very interesting and of great scientific value, and fully justifies the great expenditure incurred by the Government in financing the Radio Research Board. It will also give the authorities and interested parties in India some idea of the work to be carried on when India has her own radio research board.

The success achieved by the Board is due to the hearty co-operation of various other Government departments. In the foreword given in these reports we find that the Post-Master General's Department contributed half the cost of investigations during the financial year 1928-29, and three quarters in the succeeding years. The University of Sydney and the University of Melbourne both provided the necessary laboratory facilities. The Department of Defence also assisted the Board by the loan of apparatus and in other ways.

The first report was issued by the Board in 1931 and contained two papers, one on 'Corrections to Field Strength Measurements with Loop Antenna' and the other on 'A Radio Field Strength Survey within 100 miles of Sydney'.

The Radio Research Board of Australia issued four reports, Nos. 2 to 5, in 1932. Report No. 2 contains two papers, one on 'The State of Polarization of Sky Waves' and the other on 'Height Measurements of the Heaviside Layer in the Early Morning'. The first of these papers has proved very useful inasmuch as these experiments of Mr. Green have conclusively proved the validity of the theory of reflection of radio waves from the Heaviside layer. It was proved by Appleton and Ratcliffe that the waves reflected from the Ionosphere in England were circularly polarized with a left-handed rotation, and they predicted that under similar circumstances in the southern hemisphere the waves would be circularly polarized with a right-handed rotation. This has been proved to be true by Mr. Green working in the Radio Research Board.

Report No. 3 contains a theoretical paper by Messrs. Baker and Green on 'The Influence of the Earth's Magnetic Field on the Polarization of Sky Waves'. This analysis has been used to calculate lines of equipolarization surrounding Sydney, and the authors predict that radio-direction finders in the southern hemisphere will be liable to small errors of bearing due to 'night effects', (*i. e.* errors in direction finding due to the presence of sky wave) when the direction finder is situated to the north of the transmitter rather than to the south.

Report No. 4 contains three papers, *viz.*, (1) 'A preliminary Investigation of Fading in New South Wales' by Messrs. Green and Baker; (2) 'Studies of Fading in Victoria' by Cherry and Martyn; (3) 'Studies of Fading in Victoria' by Cherry. Such studies are very important in finding out the coverage (area

round a transmitting station over which no fading and atmospherics are experienced) of a broadcasting station. It is well known that some areas which have satisfactory day-time service are subject to severe fading after sunset. In a country, like Australia or India, which has towns and cities separated by large distances and where very large areas have to be covered by a few broadcasting stations, the presence of unfavourable conditions for propagation of ground waves may severely curtail the satisfatory service area of many stations, and studies of this type are very useful.

Report No. 5 contains a paper by Messrs. Munro and Huxley on 'Atmospherics in Australia. The results obtained decidedly show that the atmospherics have their origin in lightning flashes and they proved useful in weather forecasting. Radio research is thus proving useful for meteorology.

Reports No. 6, 7, 8 were published in 1935 and form an interesting and useful reading.

Report No. 6 contains four papers, *viz*: (1) 'On the Rotations of the Plane of Polarization of Long Radio Waves' by Messrs. Green and Builder; (2) 'A Field-Intensity Set' by Messrs. Green and Wood'; (3) 'Measurements of Attenuation, Fading, and Interference in South Eastern Australia at 200 kilocycles per second' by Messrs. Munro and Green; and (4) 'Frequency Recorder' by Messrs. Martyn and Wood.

The first of these papers shows that the technique of magneto-ionic theory gives a feasible explanation of some long-wave anomalies in remarkable quantitative agreement with the measurements of Hollingworth, who in 1927 discovered a regularly occurring cycle during sunset and sunrise in which the plane of polarization of the downcoming waves changes rapidly from the steady night value of about 40° to the steady post-sunrise value of 50° to 60°.

Paper No. 2 describes a field intensity set using a special vacuum-tube millivoltmeter capable of measuring the intensity of both the sky as well as the ground wave.

Paper No. 3 gives results for the conductivity of earth including mountainous and forest regions. Average values of intensity of field due to the sky wave per kilowatt power radiated have also been given.

The fourth paper contains the principles and designs of a semi-continuous frequency recorder, capable of recording several frequencies simultaneously. The principle used here is shown to be applicable to the recording of the ionospheric layer heights.

Report No. 7 contains four papers: (1) 'The Propagation of Medium Radio Waves in the Ionosphere' by Dr. Martyn. In this paper all available measurements of sky-wave intensities on medium frequencies are expressed as field strength distance curves and it is shown how this material can be used for the determination of non-fading service area of a broadcasting station. The data are also shown to give a value of the reflection coefficient of the Kennelly-Heaviside layer pointing to an exponential ionization gradient. The value of the collision frequency of electrons with ions is found to be in agreement with the estimates of Chapman. (2) 'The characteristics of Downcoming Radio Waves' by Drs. Martyn and Green. This paper gives a method involving the use of three aerial systems for receiving signals, which makes it possible to determine all the electrical and geometrical characteristics of the downcoming waves and their variations from second to second. At times the polarization of the downcoming waves is found to depart from circular form, which seems to depend upon the angle between the downcoming wave and the earth's magnetic field. (3) 'The Influence of Electric Waves in the Ionosphere' by Drs. Bailey and Martyn. This paper is a theoretical explanation of the Luxembourg Effect (for more details see elsewhere in this issue), and it is shown how a powerful radioemitter is capable of appreciably modifying the collisional frequency of electrons with the molecules in the ionosphere. In this way it has been possible to explain theoretically the observations of Tellegen, *viz*. the presence of signals from the Luxembourg Radio Station when the radio receiver in Holland is tuned to the signals coming from the Beromunster Radio Station. (4) 'Long Distance Observations of Radio Waves of medium Frequencies' by Drs. Martyn and Green. This paper describes the results obtained by using the frequency change method for studying reflection from the ionosphere. Two receivers were used at distances of 25 km and 700 km and it was found that at 700 km several downcoming waves were present. The equivalent

heights for the Kennelly-Heaviside and the Appleton region were found to be the same from observations at both the stations. The equivalent height for the F-region (Appleton region) was found to have a pronounced minimum at 3 A. M. each morning. The figures for ionization densities for the lower region are also given.

Report No. 8. contains 2 papers (1) 'Simultaneous Observation of Atmospherics with Cathode Ray Direction-Finders at Toowoomba and Canberra' by Messrs. Munro, Webster, and Higgs. It is pointed out that considerable directional error may exist because of the nonvertical strokes of lightning flashes and due to the presence of sky wave from distant flashes. A method is also suggested for minimizing the same. A map showing the summer distribution of sources in Eastern Australia is given from which relative severity of the atmospheric interference in different parts of Australia could be calculated. (2) 'Atmospheric Interference with Reception' by W. J. Wark. The equivalent power of the radiation emitted by an average lightning flash as measured by receiving sets tuned to different wavelengths is shown to vary as the square of the wavelengths to which the sets are tuned. From the statistics of the thunderstorm incidences it is found that the interference with a broadcast signal is proportional to the number of thunderstorms per year within the area of interference.

Need of a Radio Research Board in India

Above we are publishing an interesting review of the research work done by the Radio Research Board of the Commonwealth of Australia under the Council of Scientific and Industrial Research.

It is clear from the short account of the activities of the Australian Radio Research Board that a considerable amount of very useful work of great scientific importance has been done by the Board during the short period of its existence. As has already been pointed out in the foreword of the reports this success is entirely due to the hearty co-operation of various other Government departments and the Universities of Sydney and Melbourne.

Australi well as India have many things in common as far as radio communication is concerned. The concentration of population in cities which are separated by considerable distances, and the large number of scattered villages in between definitely point out to the necessity of a small number of high powered transmitters situated at suitable places. This is all the more necessary here in India, since at present India is not so much radio-minded as to justify the tremendous initial outlay of many broadcasting stations. But it is absolutely essential that the transmitters must be located at such places that the coverage area of the station is as large as possible so that the maximum number of people may be able to listen to programmes at good signal strength free from fading and atmospheric troubles.

From the little experience that we have about programme reception in India, no difference of opinion seems to exist about the fact that for most places the atmospherics are so severe that for the greater part of the year the programme value of the existing stations is reduced to zero. Therefore it is necessary to locate the centres of origin of the atmosphere as has been done in Australia, and take the advantage of such knowledge for the location of fresh broadcasting stations so that minimum interference may be experienced with broadcast reception.

The meteorological aspects of such studies have also to be considered. Thunderstorms are usually classified into two types, heat and frontal, the first of which originates from local surface heating, while the second in or near a frontal zone separating two different air masses. Such fronts are usually found to move with a velocity of the order of 30 to 50 kilometers per hour and a study of the movement of these fronts is very useful in weather forecasting. Such a task can be easily performed with the help of a cathode-ray direction finder, since the region kept under observation by such an instrument amounts to some millions of square miles. The ability of the cathode-ray direction finders to register rapidly the bearings of a thunderstorm is bound to have a definite use for aviation. The scarcity of meteorological observatories in India shows the necessity of this type of work, which can be easily undertaken by the universities well equipped for such work.

It is very gratifying to know that of late radio research work has been undertaken by some of the

Indian universities, and particular attention should be drawn to the excellent work done by the Calcutta and the Allahabad Universities which have received recognition abroad.

Sir Lewis Fermor, F. R. S., the late Director General of Geological Survey of India, while presiding at the Symposium on Ionosphere (for summary of which see SCIENCE AND CULTURE, Oct, 1935), organized by the National Institute of Sciences, said that it was very creditable that with the small resources at their disposal the Universities of Calcutta and Allahabad could carry out successfully a programme of radio research which in other countries was carried on by radio research boards financed entirely by the governments concerned. He pointed out the necessity of liberal financial support to the institutions carrying on such work and also emphasized that the Government of India should take the lead into the matter and constitute a radio research board in India similar to those found elsewhere. We, on our part, strongly support the suggestion of Sir Lewis Fermor and wish to add that the initiation of a programme of research in radio, carried on in co-operation with universities, will ultimately save millions of rupees and render radio propagation successful in India.

Editor, SCIENCE AND CULTURE.

The Luxembourg Effect

or

The artificial Disturbance of the Ionosphere

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Wireless telegraphy is usually regarded as one of the marvels achieved by science, but it is not usually recognized that more marvels are in store in this line. The knowledge is common now that the long distance propagation of wireless waves is rendered possible by the existence of charged particles (free electrons) in the upper atmosphere, existing at a height of from 80 to 250 kilometres.

As we go higher up in the atmosphere, we get more and more free electrons which reflect these waves just as a polished metal piece reflects light. This region of the atmosphere is now known as the *Ionosphere*. Its lowest layer E_1 becomes effective at a height of 80 kms, but there are other layers at greater heights E_2, F_1, F_2, etc. If a wireless wave be sent from Delhi and is received at Calcutta, we can suppose that the wave has travelled from Delhi to a height of 80 kms in the sky above Allahabad, and from there is reflected to Calcutta.

Sometimes while listening to radio broadcast, we are disturbed by atmospherics producing crackling noise. Such disturbances are mostly produced by banks of cloud in the path of the radio wave. These clouds have their sides charged with opposite kinds of electricity. If the cloud just discharges itself during the transmission of the wave, the ionosphere is disturbed, and this is reproduced in our receivin apparatus as unpleasant crackling noise.

Can the ionosphere be artificially disturbed? If a cloud discharge can disturb the ionosphere, certainty the operations of a powerful radio station can do the same thing. Thus in our illustration, if there be a powerful radio station in operation at Allahabad during the passage of the wireless wave from Delhi to Calcutta, it is quite possible that the wireless

message received at Calcutta will bear the impression of the disturbance of the ionosphere due to the Allahabad station.

This effect was accidentally discovered by B. D. H. Tellegen, who reported in 1933 (*Nature*, *131*, 840, 1933) that while listening at Eindhoven in Holland to the programmes transmitted by the Beromunster Broadcasting station in Switzerland, he could faintly hear the programme broadcast from the Luxembourg broadcasting station.

On first consideration it may appear that this phenomenon might be due to a defective receiver, which might have been unselective, but this possibility is ruled out since the wavelength used by the two broadcasting stations differed very widely (the Beromunster programmes and the Luxembourg programmes were broadcast on 461 metres and 1190 metres respectively).

Now a glance at *the map of Europe* will show that Eindhoven, Luxembourg, and Beromunster approximately lie in a straight line with Luxembourg in the middle.

If a wireless signal be sent from Beromunster, the ground ray cannot reach Eindhoven, but it is the ray reflected from the lower portion of the ionosphere, also known as the Kennelly-Heaviside layer, which reaches Eindhoven. Now the part of the Kennelly-Heaviside layer which is effective in reflecting the ray to Eindhoven is just over Luxembourg, and it is but natural that this should be disturbed electrically by the Luxembourg station which is one of the most powerful stations in Europe. It is rated as 150 kilowatt transmitted, while the Bombay and Calcutta stations are each 3 kilowatt and Delhi 20 kilowatt.

A résumé of results of special Luxembourg tests has been recently published by Dr. B. Van der Pol (*Tijdschr. Nederlandsch Radiogenoot*, Sept., 1935). The conclusions arrived at are summarized here.

The effect due to a long-wave station is of the order for the wanted long wave and also for the wanted medium-wave station. The effect diminishes steadily with the distance between the unwanted station and the middle point of the wanted and the receiving stations and it practically vanishes when this distance exceeds 600 kilometres.

A very elaborate mathematical theory of this effect, *Luxembourg Effect*, as it is now known, has been given by Bailey and Martyn working in the Radio Research Board of Australia. The reflecting power of the ionosphere depends upon the number of free electrons at the layer, as well as upon the number of collisions suffered by each electron with the gaseous molecules present. This last result follows from Lorentz's classical theory of reflection by a free electron cloud. Bailey and Martyn find that when the Luxembourg station sends up its modulated waves and disturbs the electrons in the ionosphere, the number of collisions suffered by each electron also changes in accordance with the modulation, thus the reflecting power of the ionosphere over Luxembourg for the Beromunster signals is varied by the modulated waves from the Luxembourg station, and the original radio signals from Beromunster is impressed with the modulation of Luxembourg radio station. When these signals are rectified and received on the telephone at Eindhoven, the Luxembourg programme is also heard in the background.

The authors have further shown that a measurement of the modulation of the disturbing station enables us to find out the number of collisions suffered by each electron at these heights. As this last effect depends on the temperature and pressure at the ionosphere this peculiar phenomenon has given us a very interesting method for studying the physical conditions in the upper atmosphere.

Notes and News

Excavations at Lauriya Nandangarh

According to press reports, the archaeological Department has decided to tap the pre-historic mounds at Lauriya Nandangarh, 15 miles north-west of Bettiah, District Champaran, Behar. Mr. N. G. Majumdar, Superintendent, Archaeological Survey, Eastern Circle, has been entrusted with the work.

The mounds have been thus described in an official publication: "The mounds are situated in the villages of Lauriya and Pakhuri and are arranged in three rows of five each, varying in height from 40 feet to about 15 feet and even less. The first row runs from east to west, the eastern most mound in it being situated some 500 feet south of the Asoka column. Near the western end of this row, and almost at right angles to it, are the other two rows running north to south, parallel to each other. The place of the fourth mound in the outer of western line of the north-south rows is occupied by a cluster of 5 small mounds only a few feet in height and hardly distinguishable from the fields around them.'

The site was visited among others by Cunningham, Garrick, and Bloch, all of whom were impressed by the unique nature of the remains. Dr. Bloch opened some of the mounds and concluded that they represent the royal sepulchres of the tribes which inhabited North Behar in the pre-Buddhistic ages. He believed that the tombs were erected in accordance with Vedic burial customs.

In the pages of Science and Culture we have often emphasized the fact that the Indus civilization was not confined to north-western India. It is possible that the present excavations may throw some light on the spread and diffusion of the Proto-Indian Culture. We hope that Mr. Majumdar, who has extensive experience of pre-historic archaeology in Sind, will be amply successful in his exploration.

India Institute of the Deutsche Akademie

India Institute of the Deutsche Akademie in its meeting on January 10th 1936 decided to announce 16 (sixteen) scholarships in institutions of higher learning in Germany available for Indian scholars (male or female) of outstanding ability for the academic year 1936-1937. The scholarships are named after great German and Indian representatives in their field of science or in honour of personalities who supported the cause of Indo-German cultural cooperation.

The scholarships are as follows:

Medicine:

1. Mary K. Das and Taraknath Das *Scholarship* (tenable at the University of Munich. Applications from women-students preferred).
2. Robert Koch—*Scholarship.*

Mathematics:

3. Ashu Tosh Mukherjee—*Scholarship.*

Indology:

4. Sir Ramkrishna Gopal Bhandarkar—*Scholarship* (This scholarship is due to a gift from the "Allianz and Stuttgarter-Lebensversicherungsbank A. G., Bln.

Chemistry:

5. Justus von Liebig—*Scholarship.*
6. Carl Duisberg—*Scholarship.*

Physics:

7. Heinrich Hertz—*Scholarship.*
8. Sir J. C. Bose—*Scholarship.*

German Language and Literature:

9. Jakob Grimm—*Scholarship.*
10. Friedrich Rueckert—*Scholarship.*

Engineering:

11. Oskar von Miller—*Scholarship.*
12. Werner von Siemens—*Scholarship.*

Archaeology:

13. Heinrich Schliemann—*Scholarship.*

Veterinary Science:

14. Wilhelm Ellenberger—*Scholarship.*

Agriculture:

15. Albrecht von Thaer—*Scholarship.*

Mining:

16. Adolf Ledebur—Scholarship (tenable at the University for Mining, Freiberg-Saxony).

All scholarships consist of 500 Marks (payable in ten monthly instalments of 50 Marks each) and exemption from the tuition fees at the University.

The scholarships are tenable for one academic year (10 months beginning by November 1, 1936, ending by August 31st 1937).

(a) If the candidate is desirous of acquiring a German degree he must be prepared to stay in Germany at least for three (mostly four) terms 1½ - 2 years. An extension of the scholarship not being sure (though possible if the student proves worthy) the student must possess sufficient means of his own for the second year of study.

(b) Apart from the scholarship the student must be prepared to spend at least 120 Marks (moderately lived) per month from his own pocket for the necessary expenses not included in the scholarship. Expenses for books have to be counted seperately; the fees for examinations, the printing of the thesis (only referring to students who want to take a degree) have to be borne by the student.

The application must contain:

(1) A survey of the previous academic career.

(2) An exact statement of the further study programme. *(If the student wants to pass the German doctorate, he should mention so).*

(3) *Copies* of all important certificates (if not in English, translations must be added). The certificates will not be returned. A statement regarding knowledge of German is desirable.

(4) Specimens of the student's work, (printed or in manuscript).

(5) Recommendational letters from two professors or other well-known personalities.

(6) A guarantee by some prominent personality that the applicant is really earnest about his application and will certainly come to Germany before September 1st 1936, if a scholarship is granted to him.

(7) A health certificate.

Applications not fulfilling these conditions cannot be taken into consideration.

All applications should reach India Institute of the Deutsche Akademie before April 1st 1936.

The applications must *directly* be sent to the following address:

Dr. Franz Thierfelder,
Hon. Secretary,
India Institute of the Deutsche Akademie
Maximilianeum, Muenchen 8,
Germany.

P. N. Bose Memorial

We are glad that an informal committee has been formed at Jamshedpur to perpetuate the memory of Mr. P. N. Bose, late of the Geological Survey of India. Mr. Bose was one of the few Indians who were able to enter the Geological Survey of India in those days and acquired in course of his service extensive knowledge of the mineral resources of the country. His services to the cause of India's industrial development have been indeed very great, as but for him the great Iron and Steel Works of Messrs. Tata & Sons at Jamshedpur would not have come into existence. Regarding his share in the foundation of this great work, the following from the *Life* of the late Mr. J. N. Tata is worth mentioning. The late Mr. J. N. Tata had an ambition of starting a great iron and steel works in India and had secured prospecting licences for the Chanda district in C. P., where large deposits of iron ore were reported. After a good deal of patient preliminary investigations, it was found that the various deposits there were mere "pockets" and that there was not enough to justify any big scale industry. "So reluctantly they (agents of Mr. Tata) had come to the conclusion that the Chanda project must be given up, and they asked Mr. Tata to inform the Government that it was not possible to start an iron and steel industry in India." When Mr. Dorabji Tata went to Nagpur to tell Sir Benjamin Robertson, the then Chief Secretary of the Central Provinces Administration, of his conclusions his attention was attracted by a map of C. P. showing heavy iron deposits at the Drug district near Raipur. His hopes were revived and on consulting "the records of the Geological Survey it was found that fifteen years earlier Mr. P. N. Bose, a Bengali, employed as a survey officer, had gone through the district looking for iron and in a report published in 1887 he had mentioned that the neighbourhood was rich in iron ore."

The prospectors lost no time and immediately secured the licence and commenced preliminary investigation. The average sample on rough analysis showed 65½ per cent of iron. Sir Thomas Holland, the then Director of the Geological Survey of India, when he first heard of it, could not believe that such rich iron ores existed in India. Mr. P. N. Bose was however destined to play a far greater part in the history of steel industry in India than the discovery of the Drug iron fields, which have been called one of the mineral wonders of the world. When the Tatas had spent about five lakhs of rupees upon the

preliminary work there and had decided to construct their iron works at Padampur, one letter from Mr. P. N. Bose informing them of the discovery of a fresh iron field, changed their whole course of action and led them to abandon the Padampur project. "One morning the Tata firm received a letter from Mr. P. N. Bose, whose name was already familiar to them by reason of his report upon the iron deposits in the Drug districts. Mr. Bose explained that he had returned from his post in the Geological Survey and was now in the employment of the Maharajah of Mayurbhanj. The Maharajah....................wanted to develop his territories and had engaged Mr. Bose to report on the mineral resources they contained. Mr. Bose, with the concurrence of the Maharajah, informed Messrs. Tata, Sons and Co. that he had found very rich deposits of iron, and invited them to send representatives to inspect the ore-fields............In the story of industrial development of India, Mr. Bose is assured of permanent mention. His inquiries were the prelude to the discoveries of Mr. Weld in the Drug area, and he now pointed the way to still more promising results. His work is one more refutation of the current criticism of the Bengalis on the supposed ground that they are not practical men."

Sir J. C. Irvine

Sir James Colquhoun Irvine, Kt., C.B.E. etc., who has been appointed President of the Quinquennial Reviewing Committee of the Indian Institute of Science, Bangalore is the Principal and Vice-Chancellor of the University of St. Andrews, Aberdeen in Scotland. He was formerly Professor of Chemistry and Director of Chemical Research Laboratory, United College, University of St. Andrews. Sir J. C. Irvine has been the recipient of numerous degrees from other societies, and the Royal Society awarded him the Davy Medal in recognition of his researches on sugars. He is at present 58 years of age, and one who knows him intimately describes him as a "*live wire.*" Since his appointment as Principal, the University of St. Andrews has made great strides as a centre of education and research.

Stratosphere Balloon reaches 72,395 ft.

The latest attempt to reach stratosphere in a balloon was made in U. S. A. on November 11, 1935. The flight was sponsored jointly by the National Geographic Society and the United States Army Air Corps, and was a complete success. Capt. A. W. Stevens and Capt. O. A. Anderson, who went up with the balloon, not only succeeded in rising to a height of 13.71 miles which is a record, but also brought down a mass of scientific informations about the upper atmosphere which will be of immense interest to physicists, meteorologists, and agriculturists. Most of these informations were secured by means of a large number of automatic recording instruments and it will take some time to decipher these records, to compile the scientific data in a systematic manner and to announce the results to the scientific world.

EXPLORER II started its ascent at 7.01 a.m. from Stratobowl which is a beautiful natural harbour for air navigation (being protected on all sides from strong wind currents by mountain ridges) in South Dakota, and landed near White Lake about 225 miles eastward. The flight lasted for 8 hours and 13 minutes. The fliers reached the pressure height at 10-30 a.m. The balloon was now actually full. On steadily discharging ballast they gradually went higher and reached the top at 11-40 a.m. The atmospheric pressure at this height was $29\frac{1}{2}$ mm. or a little over an inch. This means that 24 out of 25 parts of the atmosphere were below them and only one part above. The temperature outside was about 70° to 78°F below zero. Capt. Stevens describes the earth and the sky as they then appeared as follows:

"The earth could be seen plainly underneath through the lower porthole and for hundreds of miles in every direction through the side portholes. It was a vast expanse of brown, apparently flat, stretching on and on. Wagon roads and automobile highways were invisible, houses were invisible.........Here and there water could be seen in the form of rivers or lakes, specially if the sun was reflected from the water's surface. No sign of actual life on the earth could be detected. To us it was a foreign and a lifeless world...................................
Overhead, the great balloon blocked our view of the sky above us. How I wished at this time that we could have a central tube in the balloon through which we could look at the zenith! I am sure that the sky would have been so dark directly overhead that we could have seen the stars at noonday..............
But at the highest angle (55° above horizon) we could see it, the sky became very dark. I would not say that it was completely black; it was rather a black with the meerest suspicion of very dark blue."

EXPLORER II was the largest balloon made so far. It was spherical in shape and had a diameter of 192 ft., and a full capacity of 3,700,000, cu.ft. It was filled with helium from 1683 steel cylinders under

high pressure. The gondola carried about a ton of scientific apparatus for various purposes. Of the large amount of scientific data collected and observations made, we may here mention a few. An automatic apparatus for collecting spores at high altitude was carried with the balloon on behalf of the U. S. Department of Agriculture and was released when the balloon had reached the top. It came down safely with the aid of a parachute and was successful in collecting spores. On downward journey, Capt. Stevens collected samples of upper air from different layers in specially evacuated flasks. A cosmic ray apparatus was carried up on behalf of the Bartol Research Foundation of the Franklin Institute and an apparatus for recording electrical conductivity of the air from the Carnegie Institution of Washington.

About the future of stratosphere flights Capt. Stevens thinks that 80,000 ft. may be attained if hydrogen is used for helium in a balloon of the same size. With a larger balloon using rubberized silk instead of cooton (which will reduce the envelope weight by 40%) 95,000 ft. may possibly be attained.

"To get still more altitude the balloon may be flown to a maximum ceiling by dropping all ballast, and saving none for descent; the gondola may be cut away at the top of the flight on a large parachute, leaving the balloon to go still higher with light automatic instruments while the gondola floats to earth with the men and the major portion of scientific apparatus."

However no plan of another stratosphere flight exists at present.

U. P. Unemployment Committee's Report

The report of the U. P. Unemployment Committee appointed by the Government in October 1934 with Sir Tej Bahadur Sapru as chairman has been released for publication. The committee held 18 public sittings in various educational centres of the province and examined 127 witnesses including 30 officials, besides a number of memoranda submitted to it.

The report lays great emphasis on the re-organization of all stages of education, primary, secondary and higher, and says that the remedy for the evil of unemployment does not lie merely in stiffening university standards or restricting the number of entrants. The true remedy on the educational side lies in (*a*) reforming primary education, (*b*) rescuing secondary education from its present position and in making it independent of university education, self-sufficient and at the same time more varied in its content, (*c*) encouraging practical research at universities and establishing more points of contact among varsities on the science side and industries, (*d*) making professional education more thorough, more efficient, and more up-to-date, (*e*) reorganizing the professions so as to secure on the one hand that the number of those joining these professions is not far in excess of the public demand and on the other secure rigorous enforcement of the standards of efficient conduct, and (*f*) creating new avenues of employment.

Apart from educational reform there must be, adds the report, development of vocational education on modern lines by establishing efficient vocational schools and giving them a proper atmosphere which they lack at present and helping the products of schools in placing them with industries and other employers of skilled labour.

So also there is need for the development of agriculture and industries on modern lines and thus providing employments to trained young men, provided landed proprietors, industrialists and businessmen take interest therein.

There cannot be one single remedy which can solve the question of unemployment nor is the problem of unemployment solved immediately; but if it is attacked systematically on a well conceived plan with resources available to the Government great relief can be given to the unemployed among educated men, while if the Government is prepared to spend more money on the development of resources in the country and on reorganizing the entire system of education and encouraging and fostering the true spirit of industrialization a great deal more may be done.

Unemployment Statistics.

The report recommends that unemployment statistics relating to educated youngmen should be maintained by Government, the universities, the education department and other departments and local board. As regards Government service it is suggested that the Government should take in hand the question of restoration of posts which had been retrenched and should also rigorously enforce rules regarding age retirement with a view to give a fair chance to youngmen and should grant no extension to a public servant after completing the 55th year.

Unemployment Among Lawyers.

Referring to unemployment among lawyers, the report says: It is attributable to the legal profession

being far too crowded. It suggests that they should be divided into two classes: those who will restrict themselves to the proper function of counsel and those who will apply themselves exclusively to drafting legal documents. A Council of Legal Education should be created.

NEW CAREERS FOR YOUNG MEN.

The report also stresses the need of creating and developing some new professions so as to provide new careers for young men. The universities should arrange for a course of instruction in journalism and librarianship and the very meagre instruction in architecture should also be expanded.

The report also recommends that a detailed industrial and economic survey of these provinces should be made with a view to finding out what industries can be developed. A scheme for helping educated young men in starting small industries should be prepared and a beginning made in certain centres. Special attention should be paid for marketing the products of cottage industries, industrialists giving them expert advice in the matter and for this purpose an institution working on joint stock lines should be established at an early date.

TECHNICAL INDUSTRIAL AND VOCATIONAL EDUCATION.

As regards technical, industrial and vocational education, the report says that the right course to follow would not be to diminish the existing facilities for them but reorganize and remodel them so as to make them more efficient.

The report suggests steps to be taken to afford advice to parents regarding the intellectual capacity of their boys and their suitability for certain careers. Referring to education generally, the report says that while it should be the aim of primary education to remove illiteracy it should also be its principal aim to qualify boys to become better agriculturists and that it should be brought more into line with the rural needs and agricultural conditions. The age limit for the purpose of primary education should be raised to 12 or 13 and every child should remain at school at least for six years.

COMPULSORY PRIMARY EDUCATION.

The report strongly recommends that compulsory education should be extended all over the province as without it economic prosperity cannot be built.

As for secondary education the High School Examination should have two kinds of certificates: one certifying completion of the course of secondary education and qualifying for admission in industrial, commercial and agricultural schools and the other qualifying for admission in arts and science intermediate colleges. The intermediate course, if the High School course is curtailed by one year, should be extended to three years and be of four parallel types: industrial, commercial, agricultural and arts and science.

UNIVERSITY EDUCATION.

As regards university education, the report says that while no arbitrary limit for admission of students should be prescribed, there should be greater strictness exercised in the matter of admission. As far as research work conducted at universities is concerned the universities should study the need and encourage such research. There should be some system of co ordination among different universities and prevent unhealthy competition.

ESTABLISHMENT OF APPOINTMENTS BOARD.

Lastly, the report recommends the establishment of an Appointments Board for the graduates of all the five universities in the province and other institutions which should be modelled more or less on the Appointments Board at Cambridge and should be financed partly by the Government and partly by universities. Similarly, there should be a board for the products of secondary schools, intermediate colleges and vocational schools, etc., and it should be financed by the Government. These boards should be required to collect statistics of employment of graduates and products of secondary schools.

Bengal Education Week

An Education Week, the first of its kind in the province, was organized by the Ministry of Education, Bengal, during the first week of February, under the patronage of H. E. Sir John Anderson. The object of the Education Week was to focus attention on education problems of to-day, and to show to the teaching profession and the general public the present state of education in the province and the lines along which further progress may be made. Demonstration lessons were arranged and a fine exhibition was organized where a large number of educational exhibits from all parts of the country were displayed and the varied work that is being done in more progressive

schools of the province were shown. The most important part of the programme was the lectures and symposia on various important educational and allied problems facing our country, particularly the province of Bengal, in which many well known educationists and other eminent persons took part. The organizers are to be congratulated on having secured the co-operation in this matter of such persons as Dr. Rabindra Nath Tagore, Sir George Anderson, Sir Ross Masood, Mr. Syamaprasad Mukerji, Mr. A. F. Rahman, Col. R. N. Chopra, Lt.-Col. Kirwan, Professor S. N. Bose, Professor M. N. Saha, Professor Radhakumud Mukerji, Sir L. L. Fermor, Sir U. N. Brahmachari, Dr. W. A. Jenkins, and a host of others. The lighter side of the programme was not neglected. Sports, games, dramatic performances, and music were arranged and among other things the programme included demonstration of *Bratachari* dance, scouting activities and mass drill. About 1500 delegates from nearly all the secondary schools and colleges of Bengal attended the Education Week celebrations.

In the course of his inaugural address H. E. Sir J. Anderson said "Since the end of the last century far reaching improvements in teaching technique have taken place in the West and those improvements have been reflected in the results achieved............The knowledge that much remains to be done to improve the ordinary teaching in our schools is not of course new. You will all, I think, agree that if India is to achieve success in her efforts to attain and maintain national greatness she cannot afford to adopt any but the best and most successful methods in the training of her youth..............India has yet to discover the methods of teaching best suited to the genius of her people. That discovery will come not through the work of one or even a few people but only through the devoted services of large numbers of enthusiastic teachers determined to experiment and evolve the best possible system. If failures in that experimental work are to be minimized, an adequate knowledge of the work that has been done elsewhere is desirable, and a close co-operation with fellow workers here in India is essential. Therein lies the justification for this Education Week."

Sir G. Anderson, Educational Commissioner with the Government of India, speaking on "Recent Developments in Indian Education", dwelt a great deal on the problems of primary education and how to achieve permanent literacy. He favoured compulsory primary education and opined that a minimum period of five years was required for acquiring permanent literacy. He thought that the Indian educational system should be reconstructed in such a way that it shall be divided into a number of separate stages, each with a clearly defined objective and untrammelled by university requirements. At the end of each stage pupils should be diverted to suitable occupations or to vocational institutions.

In a lecture on "Examinations", Dr. W. A. Jenkins, the Director of Public Instruction, Bengal, deplored that examinations have become soul-destroying masters instead of remaining, as they should be, useful servants. He then discussed the defects of modern examinations and other possible types, preferred the German system of internal examinations for the non competitive type of examination. Professor S. N. Bose gave a lecture on "Place of Science in Education", in which he said "If education was to be regarded as a means of effecting an adjustment between man and his environments, the supreme importance of scientific study must be recognized". He laid great emphasis on the selection of right type of teachers and suggested that there should be a periodical by which the teaching profession could keep in touch with modern developments. He concluded by urging that there should be close co-operation between our educational institutions and industrial organizations. Professor M. N. Saha speaking on "Science in the Aid of Economic Problems of Bengal", said that Bengal's condition can be much improved if scientific methods are applied to agriculture. He said that Bengal badly needed crop-planning. Government should help the peasants in raising new money crops like cotton and sugarcane and should encourage sericulture. There should also be a Central Jute Research Institute on the lines of the Central Cotton Research Institute. He also suggested the establishment of a first grade agricultural college in Bengal for investigating her agricultural problems. Sir Ross Masood speaking on "Indian Vernaculars" strongly deplored the use of a foreign language as the sole medium of our higher education.

The Education Week came to a close with an address of Dr. Rabindra Nath Tagore on "The Ideals of Education". He put forward a strong plea for vernacularizing our education, but admitted that under the present circumstances the teaching of English can not altogether be done away with.

"The material poverty of our country", Dr. Tagore went on, "is a matter of painful sorrow for us, but the inertness of our present education is a matter of profound shame. The root cause of this inertia is

that our educational system is unnatural: it has no relation with the life current of our people. The vehicle for the mental development of our people must, above all, be natural but in our case it has become altogether artificial and alien. This deficiency in our modern education is a standing disgrace to our national history. It dwarfs the intellectual enlargement of the entire Indian nation. The wide gulf between the mind of our people and the education imparted to them has long pained me. I have come here not to say anything new, but to draw your attention once again to the painful story of our present-day education so that something may yet be done towards making it naturalized. The most accepted, and yet most neglected, truth about education is that it should be *living* and *universal*, not mechanical and the privilege of the few. Our educational institutions, in order to obtain their fulness of truth, must have close association with the economic life of the country. Our education should be so designed as to help us to realize the inner principle of the unity of all knowledge and all the activities of our social and spiritual being.

"The society, whose only minor section enjoys the light of education, but which allows its major section to grope into the darkness of ignorance, is sooner or later doomed to destruction. Outside India I have been to many countries, both in the East and in the West. I saw that in this age of awakening leaders had everywhere accepted the responsibility of spreading education and enlightenment among the masses. Excepting some dark, barbaric regions in this world, India is the only country where hardly eight or ten persons among every hundred know how to read. Under such tragic circumstances we must be ashamed to indulge in mere discussions of educational problems. In fact those countries which neglect the education of their masses will miserably lag behind in this age of progressive ideas and experiments. No civilized nation can rest content with cheap excuses of want of money while combating illiteracy among its members."

The function came to a close with an appropriate speech by the Minister for Education.

India's Coal Reserve

In his presidential address to the Asiatic Society of Bengal, Sir L. L. Fermor drew the attention of the country to the serious problem of India's poor coal reserve. It is estimated (See *Science and Culture*, Sept. 1936, p. 192) that India still possesses about 4,500 million tons of good coal. This would last for about 200 years at the present rate of consumption (22,500,000 tons annually), if the whole of it could be extracted. But due to faulty methods of mining, the actual amount extracted is 50% or even less. This means that assuming no further growth in our annual consumption, the reserve will be exhausted within 100 years. Again in the Jharia field much coal that could have been recovered will be lost due to subsidence and fire. To remedy this deplorable state of affairs, he suggested the formation of a Coal Conservation Department by the Government. He also referred to the recommendations of the Coal Committee of 1917 which had recommended State control of the industry. No action was, however, taken on the report.

Research Notes

A new Growth-promoting essential Amino Acid

W. C. Rose and collaborators in a series of papers detailing the results of feeding experiments with mixtures of highly purified amino acids demonstrated that growth-promoting proteins contain at least one essential dietary component other than the twenty known amino acids. They found that young rats fail to maintain themselves upon diets carrying a mixture of nineteen amino acids of known composition in place of proteins. But on the other hand the addition to such a ration of a concentrate of the monoamino acids is followed immediately by growth. This unknown growth-essential which has hitherto been recognized by the authors as a single entity is now proved to be composed of two factors. They have now been separated by their solubility difference in aqueous butyl alcohol. The more soluble component has been identified as isoleucine. By several procedures exceedingly laborious McCoy, Meyer and Rose (*J. Biol. Chem. 112*, 283, 1936) have been able to isolate the other growth-essential also in pure crystalline form, manifesting maximum nutritional action. The yield is about 0.8 gm per kilo of fibrine. Physiological experiments show that this crystalline product added to an otherwise adequate diet to the extent of 0.6% is approximately the minimum amount which must be in the food in order to induce maximum growth in rats. The chemical composition etc. have been determined and the substance is identified as one of the four isomeric α- amino- β- hydroxy- n- butyric acid. The authors claim that the feeding trials adopted by them constitute the first successful attempt to rear animals on diets containing mixtures of highly purified amino acids as the sole source of nitrogen and may be utilized to establish the physiological significance of other amino acids.

Eventually such data may provide a new and final answer to the question of the protein requirements of man and animals.

H. N. B.

The X-ray and the Oil-drop Values of e.

Backlin's[1] absolute determination of the wave lengths of a number of lines in the X-ray region with the help of plane gratings showed that these absolute λ values (λg) are greater by about 0·25% than the corresponding crystal values (λc). On using λg to calculate the lattice constant d of a crystal, it is found that the conventional d values are too small. Since the uncertainty in d is mainly due to the uncertainty in the value of Avogadros number, i. e., to the value of e the electronic charge, λg may be used to calculate e. Such values were found to be higher than the value of e given by Millikan's oil drop method, the difference lying outside the limits of experimental error. This discrepancy gave the incentive to a search into possible causes of error in the grating method, but the problem remained unsolved. Thinking that some other method of absolute determination of λ will throw light on the problem, Bearden[2] employed the refraction method and found the λ values to be in better agreement with the crystal values. But later work by himself and Shaw[3] showed that such measurements favoured the grating values.

In the meantime Shiba[4] had challenged the correctness of Millikan's assumption regarding the viscosity of air (μ). Adopting $\mu = 1831{\cdot}2 \cdot 10^{-7}$ as the best average value (Millikan used $\mu = 1822{\cdot}7 . 10^{-7}$) he finds e by Millikan's method to be equal to $4.803 . 10^{-10}$ while the X-ray e value is $4{\cdot}8036 \pm {\cdot}0005 . 10^{-10}$. Recently Kellstrom[5] has determined λ very carefully and found the value to be $1834{\cdot}8 . 10^{-7}$. This makes $e = 4{\cdot}816 \pm {\cdot}013 . 10^{-10}$ when used with Millikan's data. Thus the discrepancy disappears.

In a recent letter to the *Physical Review* Birge[6] discusses these values. Though the discrepancy between the oil drop and the X-ray e values disappears, he shows that the problem of the values of the three inter-related constants e, e/m and h is not setted. Earlier[7] he has shown that a single set of values for these three constants does not

satisfy all the experimental facts. This difficulty remains even with this new value of e.

(1) Backlin, *Dissertation*, Upsala, 1928.
(2) Bearden *Phys. Rev.*, *39*, 1, 1932.
(3) Bearden Shaw, *Phys Rev.*, *46*, 759, 1934.
(4) Shiba, *Sci, Pap. Inst. Phys. Chem. Research*, Tokyo *19*, 97, 1932.
(5) Kallstroem, *Nature*, *136*, 682, 1935.
(6) Birge, *Phys. Rev*, *48*, 918, 1935.
(7) Birge, *Science*, *79*, 438, 1934.

D. P. R. C.

Mechanical Stimulation of Plant Respiration

Recent publications from the Botany School, Cambridge, draw attention to a new and interesting problem of mechanical stimulation of plant respiration. H. Godwin (*New Phyto. 34*, 403, 1935) reports that he conducted some experiments on leaves of cherry laurel (*Prunus lauro-cerasus*) in 1925 and found that respiration rate greatly increased by slight handling resulting from mere transfer of leaves from one chamber to another. This led L. J. Audus (*New Phyto. 34* 368-402, 1935,) to investigate the problem more fully. He stimulated the leaves of the same species by rubbing both sides of the lamina by a duster. This stimulation of contact resulted in increasing the respiration rate, in some cases to as much as 3 times the value before stimulation. The high value of respiration, however, gradually fell down and, in typical cases early in starvation life of the leaf, reached the normal drift in about 60 hours. Successive stimulations at short intervals did not increase the respiration to any great extent above the initial rise, and a sort of fatigue developed after stimulation which disappeared when the normal drift was reached. In most cases during the fall to the normal there was an interruption in the shape of a step or a secondary rise in about 24 hours from stimulation. On the leaves in senescent phase the stimulation had a double effect in that the respiration rose to the maximum and fell rapidly reaching the normal in 12 hours and then continued to fall to a value below normal before slowly returning to the normal drift. This effect led the author to conclude that the total effect could be divided up into a stimulatory effect and a depressant effect whose appearance was intimately connected with the senescence of the leaf and which took longer time to develop and acted longer than the stimulatory effect. J. Baker of Low Temp. Res. Station, Cambridge, in the same issue of the journal (407-8) also points out that gentle squeezing of potatoes which were soft owing to loss of water and senescence resulted in an immediate increase or about 30% in respiration which took 10 days to fall gradually to the initial value.

N. L. Pal.

Sexual Reproduction in Allomyces Arbuscula

This remarkable aquatic Phycomycete was discovered in India and described by Butler in 1911, who obtained it from Pusa and Poona. Later several investigators in the United States have worked on this fungus but all of them failed to obtain sexual reproduction in it. In 1929 Kniep of Berlin discovered sexuality in an allied species *A. javanicus* in which he found conjugation of heterogamous ciliated swimming gametes. It was the only such case recorded in the Phycomycetes and indeed it was so unique that mycologists regarded this as a tentative one. In 1932 the writer was able to collect *A. arbuscula* at Allahabad and, with a view to test Kniep's results in an Indian species, made numerous experiments to obtain the sexual stages but only with negative results.

Recently Hatch has succeeded, by a special method, in obtaining sexuality in *Allomyces arbuscula*, thus confirming Kniep's observations, in nearly all details. He finds that the male and female gametangia are produced in pairs, the former being smaller and salmon-pink, the latter terminal and ashen-grey. In their formation the nuclei, containing six chromosomes, and the lipoid granules are distributed approximately equally between the male and female gametangia. The latter, however, receives a disproportionately larger number of chondriosomes, which here seems to be of primary importance in the determination of sex. The more active male gamete and its nucleus are about half the size of the female. The nuclear cap is chondriosomal in origin and is analogous to those found in the spermatozoids of mosses or certain insects. This confirmation of peculiar sexuality in *Allomyces* has also settled the nature of the thick-walled sporangia which are chlo-

mydospores and not parthenogenetic oospores as suggested by Butler.

A. M.

Hatch, W. R.—Gametogenesis in *Allomyces Arbuscula* *Annals of Botany*, 49, 623-649, 1935.

Effects of Animal Hormones on Plants

The literature dealing with the effect of animal hormones on plants is scanty and somewhat contradictory. It is possible that different plants are affected differently by the same hormone or that different concentrations of the same hormone produce different results in the same species.

László Havas and John Caldwell (*Annals of Botany*, Oct., 1935), have *reported* some *experiments* in this line. Hormones were introduced into the plants by adding hormone-extracts to the culture solutions in which rooted plants were growing and also by "cutting a petiole and using the negative pressure in the water stream to pull solutions into the plant through the petiolar stump."

Tomato plant treated with oestrogenic substance developed a larger root system than that of the controls. The size of the aerial part was equal to the similar part of the controls although the hormone-treated plants had to recover from the tissue damage caused by the entry of the hormone substance. The hyacinths showed an increase in size when treated with very large doses of thyroid extract. Extracts of testes and of the anterior lobe of the hypophysis failed to induce any increase in size.

Adrenalin did not increase the root pressure of plants and showed no effect on the respiratory mechanism.

None of the hormones used, including testes and ovary extracts, showed any *effect on the flowering* of tomato plants. Some of the hormones appear to have increased flower development in hyacinths. Thyroid extract however did not affect hyacinths in either direction.

U. N. Chatterji.

University and Academy News

Asiatic Society of Bengal

Medical Section

A joint meeting of the medical section of the Asiatic Society of Bengal, the Calcutta School of Tropical Medicine, and the All-India Institute of Hygiene and Public Heath was held in the Lecture Theatre of the Calcutta School of Tropical Medicine, Central Avenue, on Tuesday, the 4th February, 1936, at 3 p.m.

The following paper was read :

K. V. Krishnan.— *The mechanism of haemolysis in malarial haemoglobinuria of monkeys.*

Summary

With a view to finding out the nature of the haemolytic agent, if any, that is responsible for haemolysis and haemoglobinuria in monkeys infected with *P. knowlesi* the biochemical changes were studied in the blood of the following four groups of infected monkeys, namely,

1. Splenectomized monkeys developing haemoglobinuria.

2. Splenectomized monkeys not developing hæmoglobinuria.

3. Non-splenectomized monkeys not developing hæmoglobinuria.

Special attention was paid to the following constituents : cholesterol—total, free, and ester ; total fatty acids ; inorganic and organic phosphorus ; and glucose. The results indicate that hæmolysis and hæmoglobinuria are associated with a fall in free cholesterol and a rise in ester cholesterol ; no change in total fatty acids ; a rise in inorganic and organic phosphorus ; and a fall in glucose. These changes when taken along with others suggest liver damage and an upsetting of the glucose and fat metabolisms. If this view is correct then it is possible that the hæmolytic agent, if any, responsible for the hæmolysis, is only a product of altered metabolism, as for example, a higher member belonging to the unsaturated fatty acid group, and that it acts when free cholesterol is low. It is suggested that the agent causing hæmolysis in blackwater fever in man is also of a similar nature.

Election of Office-bearers

In the annual meeting of the Asiatic Society of Bengal held on the 3rd February 1936, the following were elected office-bearers for 1936 :

President : His Excellency Sir John Anderson.

Vice-Presidents : Sir David Ezra, Sir Upendra Nath Brahmachari Bahadur, Lt.-Col. R. Knowles, Sir B. L. Mitter.

General Secretary : Mr. Johan van Manen.

Treasurer : Dr. S. L. Hora.

Philological Secretary : Mr. S. K. Chatterjee.

Joint Philological Secretary : Shamsu'l Ulama Mawlawi M. Hidayat Hosain, Khan Bahadur.

Natural History Secretaries : Dr. Baini Prashad and Dr. J. N. Mukherjee.

Anthropological Secretary : Rai Bahadur Ramaprasad Chanda.

Medical Secretary : Lt.-Col. R. N. Chopra.

Library Secretary : Dr. A. M. Heron.

Members of Council : Mr. Percy Brown, Mr. C. C. Calder, Mr. N. G. Majumdar, Lt.-Col. N. Barwell. Mr. K. C. Mahindra, Mr. M. Mahfuzul Haq.

Dr. S. K. Chatterji, Dr. A. M. Heron, Mr. N. G. Majumdar and Nawab Habib-ur-Rahman Shirwani were elected Ordinary Fellows.

The following medals and prizes were announced :-

Barclay Memorial Medal -Dr. Birbal Sahni, D.Sc, Professor of Botany Lucknow University, Lucknow ; Joy Gobind Law Memorial Medal - Prof. L. S. Berg, Chief of the Bureau of Applied Ichthyology and Professor of Geography, State University, Leningrad, Russia ; Elliot Prize for Scientific Research—Mr. Kalipada Biswas, Royal Botanic Garden, Sibpur, Howrah.

The Academy of Sciences, U. P.

The ordinary monthly meeting of the Academy of Sciences, U. P. was held in the Physics Lecture

Theatre, Muir College Buildings, Allahabad, on the 17th December, 1935, with Prof. N. R. Dhar, president of the Academy, in the chair.

The following papers were read and discussed :-

1. M. S. Desai, Surat : The Study of the Absoption Spectra of Lead Fluoride.
2. N. L. Pal, Allahabad : Hydrogen ion concentration and titratable acidity at different stages of fruit ripening."
3. B. S. Srikantan & S. Rengachari, Madras : Utilization of Waste Vegetation—I. Gasification of Prickly Pear (Opuntia Dillinii).
4. D. S. Kothari, Delhi and R. C. Mazumdar, Lahore : The Quantum Statistics and the internal Constitution of the Planet.
5. M. N. Saha and L. S. Mathur, Allahabad : A critical Review of the current Theories of the active nitrogen phenomenon.
6. Prof. Satyendra Ray, Lucknow : On Sulaiman's Single Journey Method.

Prof. M. N. Saha and Mr. L. S. Mathur gave a short account of the phenomenon of active nitrogen which has proved a puzzle since the beginning of the century. Nitrogen is known to be a very inert gas, but it was discovered by E. P. Lewis that when a particular kind of discharge is passed through it, it becomes extremely reactive. A theory was given nearly ten years ago by Prof. Saha and Dr. N. K. Sur, as a result of which a good deal of interest was excited in the subject, and a large amount of work was done in Europe and America. Various modifications of the theory have been proposed by German and American workers, but it was shown by the authors that all these theories fail to explain all the features of the phenomenon. Recently, Lord Rayleigh has found that nitrogen once activated keeps its glow for five hours, and thus light may be said to have been bottled up. The authors propose a new modification of their old theory and suggest experiments whereby the theory may be experimentally tested.

In Chapter VII of his *Mathematical Theory of a New Relativity*, Section 1, on "the Single Journey Method" Sulaiman refers to the "impossible assumption" of common time of Einstein.

The physical basis of it with Einstein is the "constancy in space" of light velocity, not only "astonishingly assumed" by Einstein, but by Sulaiman as well. The absurdity of $r/(c-v)$ and $r/(c+u)$ being equal, therefore, does not arise.

In fact it is well known that the expressions of Einstein for the relative velocity are symmetrical in u and v, and so are those of Sulaiman, Sulaiman actually claiming that Einstein's expressions tumble out of his as a first approximation.

In the arithmetical work, in which the astonishing and impossible assumptions of Einstein are proved to be wrong, Sulaiman has confused t for dt, and $(s+ds)$ for ds in Newtonian definition of velocity as ds/dt.

The following candidates were elected by ballot as ordinary members of the Academy of Sciences, U. P. :

1. Prof. George Matthai, Professor of Zoology, Punjab University, Lahore.
2. Dr. Bhola Nath Singh, Kapurthala Professor of Agricultural Botany and Plant Physiology, Head of the Institute of Agricultural Research, Hindu University, Benares.
3. M. L. Bhatia Esq., Lecturer in Zoology, Lucknow University, Lucknow.
4. Dr. S. N. Das Gupta, Reader in Botany, Lucknow University, Lucknow.
5. Prof. N. N. Sen Gupta, Professor of Philosophy & Psychology, Lucknow University, Lucknow.
6. Amar Nath Tandon Esq., Physics Deptt., Allahabad University, Allahabad.
7. K. Ahmad Chowdhary Esq., Wood Technologist, Forest Research Institute, Dehra Dun.

The National Academy of Sciences, India

The ordinary monthly meeting of the National Academy of Sciences, India, was held in the Physics Lecture Theatre, Muir College Buildings, Allahabad, on the 1st of February, 1936, with Prof. N. R. Dhar, president of the Academy, in the chair.

The following papers were read and discussed :

1. P. L. Srivastava, Allahabad : On the Phragmen-Lindelog Principle.

2. Krishna Lal Gupta, Allahabad : On the Convergence and the Summability of the Conjugate Series of the derived Fourier Series

Indian Chemical Society

The twelfth annual general meeting of the Indian Chemical Society was held on Monday the 6th of January 1936, in the chemistry section room, Daly College, Indore.

In the absence of the president, Sir U. N. Brahmachari, Dr. Dhar, one of the past presidents, took the chair.

1. (*a*) The chairman read the following nominations of the office-bearers, made by the Council, which were carried unanimously.

Vice-Presidents :	Prof. Dr. H. B. Dunnicliffe Prof. Dr. J. C. Ghosh Prof. Dr. P. C Mitter
Hony. Secretary :	Mr. P. Ray
Hony. Treasurer :	Prof. Dr. Sudhamoy Ghosh
Hony. Auditors :	Mr J. P. Mookharjee } Chartered Mr. P. C Nandi } Accountants

The election of the following four ordinary members was carried unanimously :

Prof. Dr. J. N. Mukherjee, Dr. P. B. Sarker, Prof. Dr. H. K. Sen, and Dr. J. N. Ray.

2. The chairman stated that the general body present at this session of the chemistry section of Indian Science Congress adopted a resolution to request the Council of the Indian Chemical Society to form a committee to investigate as to the possibilities of preparing fine chemicals in India for the laboratory use.

The chairman read the following resolution of the Council as arising out of Dr. Dhar's proposal. The chairman also read the personnel of the committee formed by the Council with power to co-opt.

It was resolved that a committee consisting of the following members with power to co-opt be appointed to consider possibilities of preparing fine chemicals for laboratory use and to collect informations regarding the possibility of new chemical industries in India.

1. Dr. H. K. Sen (Calcutta), 2. Dr. J. N. Mukerjee (Calcutta), 3. Dr. S. K. Ray (Dhanbad) 4. Dr. P. K. Ghosh (Calcutta), 5. N. N. Godbole (Benares), 6. Dr. J. K. Chowdhary (Dacca), 7. Dr. N. R. Dhar (Allahabad), 8. Dr. P. C. Guha (Bangalore), 9. Dr. P. C. Mittra (Convener), 10. Dr. T. S. Wheeler (Bombay), 11. Dr. S. Sastry (Mysore), 12. Dr. B. Sanjiva Rao (Bangalore), 13. Dr. K. L. Moudgill (Trivandrum), 14. Dr. S. S. Bhatnagar (Lahore), and 15. Dr. M. S. Patel (Bombay).

The following fresh names were added to the list by the general body in the meeting.

1. Dr. K. H. Hassan (Hyderabad, Deccan).
2. Dr. B. S. Srikantan (Waltair).
3. Dr. N. G. Chatterjee (Cawnpur).

The budget estimate for 1936 was accepted and several important resolutions were adopted.

Indian Physical Society

The second annual meeting of the Indian Physical Society was held on January 6, 1936, in the room of the section of mathematics and physics, Indian Science Congress, Indore.

In the absence of the president and vice-presidents, Prof. A. C. Banerjee of Allahabad, took the chair.

1. As a result of scrutiny of the ballot papers the council for the year 1936 was constituted as follows :

President : Prof. M. N. Saha, Allahabad.

Vice-Presidents : Principal B. M. Sen, Calcutta,
Prof. G. R. Paranjpe, Bombay.

Gen. Secretary : Prof. D. M. Bose, Calcutta.

Treasurer : Prof. P. N. Ghosh, Calcutta.

Council : (1) Prof. K. Prasad, Patna ; (2) Prof. J. B. Seth, Lahore ; (3) Dr. S. K. Banerjee, Poona ; (4) Prof. H. P. Waran, Madras ; (5) Prof. N. R. Sen, Calcutta ; (6) Prof. B. B. Ray, Calcutta.

2. The annual report was read and accepted.

Special Meeting

A special meeting of the Indian Physical Society was held on Saturday, the 8th February, 1936, at 1 p.m., in the Chemistry Lecture Theatre, University

College of Science, 92, Upper Circular Road, Calcutta, and the following papers were read :

(*i*) On the Origin of Mass in Neutrons and Protons.—Prof. M. N. Saha. Allahabad.

(*ii*) The Nature of Binding in $SnCl_2$—Mr. H. K. Trivedi, Allahabad.

There was a large and distinguished gathering including many scientists of note.

Calcutta Mathematical Society

The annual general meeting of the Calcutta Mathematical Society was held in the Society's room on the 26th January, 1936, at 4-30 p. m., with Prof Syamadas Mookherjee, president of the Society, in the chair. There was a large and representative gathering of distinguished mathematicians and scientists from Calcutta and outside.

The Secretary presented the annual report of the Society and the auditor's report regarding the financial state of the Society for the year 1935. These reports showed considerable improvements in the numerical strength and in the financial condition of the Society.

The following gentlemen were elected office-bearers and members of the Council for the year 1936.

President : Professor Syamadas Mookerjee, Calcutta.

Vice-Presidents : Dr. S. C. Bagchi, Calcutta; the Hon'ble Sir S. M. Sulaiman, Allahabad; Principal B. M. Sen, Calcutta; Professor C. V. Hanumanta Rao, Lahore; and Dr. N. N. Sen, Calcutta.

Treasurer : Mr. Satis Chandra Ghosh, Calcutta.

Secretary : Mr. S. K. Chakravarti, Calcutta.

Members of the Council : Professor N. R. Sen, Calcutta; Dr. P. L. Srivastava, Allahabad; Professor A. C. Banerjee, Allahabad; Dr. M. R. Siddique, Hyderabad; Dr. S. M. Ganguly, Calcutta: Mr. Ramaprasad Mookerjee, Calcutta; Professor N. M. Basu, Dacca; Mr. N. C. Roy, Calcutta; Dr. C. N. Srinivasienger, Bangalore; Dr. J. Ghosh, Calcutta; Dr. R. N. Sen, Calcutta; and Mr Bholanath Mookerjee, Calcutta.

The following papers were read :—

1. Prof. N. R. Sen : On the smoothing out of irregularities of the motions of Spiral Nebulae according to the Expansion Theory of the Universe.

2. Mr. M. Ghosh : On the theory of extensional vibration of a string struck by an elastic hammer.

3. Mr. Monohar Ray :—On a problem in the stability of a circular vortex.

The following gentlemen were elected as ordinary members of the Society :—

(1) Mr. D. N. Mukherjee, Chandernagore, and

(2) Mr. B. Chakravarty, Serampore.

Prof. F. Levy, Hardinge Professor of Higher Mathematics, Calcutta University, delivered a learned lecture on the application of the Galois-Field to *n*-dimensional Geometry",

University of Allahabad

Dr. R. K. Saksena of the Botany Department, University of Allahabad, carried on researches under the eminent cytologist, Professor A. Guilliermond, Director of the Sorbonne Botanical Laboratory. He has recently been awarded the *State Doctorate* in Science with "*Tres Honorable*" by the University of Paris on *Recherches Physiologiques et Cytologiques Sur quelques especes du genre Pythium*'.

It is an honour to him that his work has been accepted by Professor Molliard, Member de l' Institut, for publication in *Revue generale de Botanipue.*

The HILL MEMORIAL PRIZE was awarded this year to Mr. Hrishikesha Trivedi of the Physics Department, Allahabad University.

It is awarded biennially on the best research work carried out in the Allahabad University both by students and teachers (excluding the senior ones) during the previous two years.

The recipient of this year's prize is also the asst. editor of the National Academy of Sciences, India.

Letters to the Editor

A Note on the Somatic Mitosis of *Crotalaria Juncea* L

A study of the root tip cells of *Crotalaria juncea* L. was undertaken with a view to study the morphology and the diploid chromosome complement of the plant. On examination of the preparations certain irregularities in the course of mitosis were observed. This note gives an account of such irregularities.

During metaphase it has sometimes been observed that the nucleolus is caught in the centre of the spindle and divides equally or unequally into two distinct portions, or

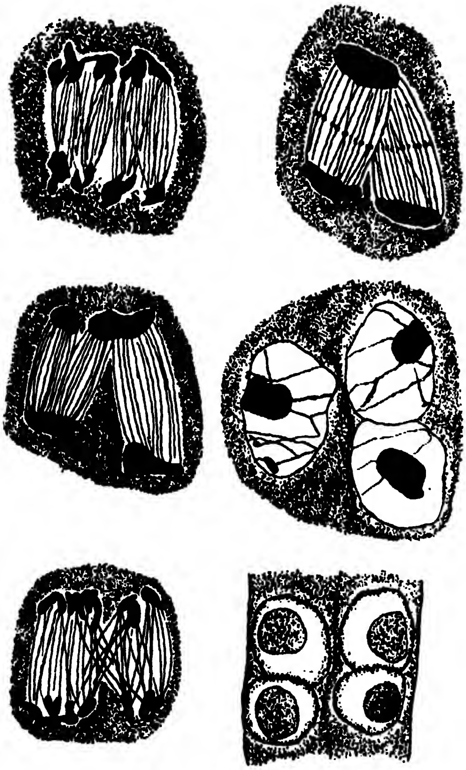


Fig. 1-6. 2, 400.

bodily moves to one of the poles and then disappears in the cytoplasm. Similar behaviour of the nucleolus has been reported previously by Frew and Bowen[1] in a number of plants, and recently by Banerji and Das[2] in *Trichcsanthes dioica* Roxb.

The anaphasic separation of the chromosomes is very sudden and all the chromosomes do not reach the poles simultaneously, but laggards have been noted. The aggregation of the chromosomes into a compact mass is noted when all the chromosomes reach the poles. A cell plate is noted on the equatorial region of the spindle and looks like a continuous film.

In some nuclei it has been observed that the chromosomes on reaching the poles do not aggregate together but remain somewhat isolated and lie in scattered groups (Fig.1), while in some again two definite groups are formed on the same pole, the grouping of the chromosomes on the other pole being normal (Fig. 2). Two distinct groups of the chromosomes on both the poles have been observed in some preparations (Fig 3). The fibres connecting the chromosomes at this stage are somewhat irregularly arranged and it appears as if the original barrel-shaped spindle has been split by some mechanical pressure. But the homogeneity of the cytoplasm between the chromosome groups at each pole and in the surrounding area is against this supposition.

It has been observed that cells which have two chromosome groups at a pole during the telophase give rise to two nuclei at that pole. As a result each daughter cell contains one or two nuclei. In those cases where three chromosome groups are observed in the telophase three nuclei are formed. On completion of the division one daughter cell contains one and the other two nuclei (Fig. 4). Where four chromosome groups are formed by the splitting of each pole of the spindle into two parts, four nuclei are formed, each daughter cell containing two nuclei (Figs. 5 & 6). The nuclei of each daughter cell later fuse so that in all fully developed cells only one nucleus is present.

Sixteen somatic chromosomes have been counted from polar views of equatorial plates. This is just twice the haploid number (8) reported previously by other workers.

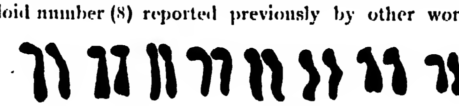


Fig. 7. × 2, 400.

The form of the somatic chromosomes varies to a certain extent. An idiogramic representation shows that they form an ascending series from right to left, but their range of variation from pair to pair is not so wellmarked although that between the longest and the shortest pair is 1. 4 microns.

Their linear measurements in microns from left to right are 3, 8, 3.4, 3.1 3.1 3.0, 2. 6 and 2. 4. A single constriction is found in each of the chromosomes and is situated sub-terminally.

Department of Botany,
Calcutta University. I. Banerji.
10. 1. 1936. K. K. Sanal.

1. Frew, E. P. and Bowen, R. H. — *Quart Jour. Micr. Sc.*, pp. 167-210. 1930.

2. Banerji, I. and Das, M. C. — *Curr. Sc.*, III pp. 487-488. 1935,

A Note on *Prasiola fluviatilis* (Sommerf) Aresch from India

The *Prasiolaceae* which are characterized by the presence of unbranched filaments or cellular expanse containing an axile stellate chloroplast with a large central pyrenoid and a single nucleus in each cell are all included in a single genus by Fritsch[1], though Smith[2] recognizes 2 genera. These algae are widely distributed in various habitats. A number of the species are marine but some fresh water forms are also known. In spite of their varied distribution they have not been reported from India. During my recent visit to Simla I found *Prasiola fluviatilis* (Sommerf) Aresch growing attached to rocks in a stream of water flowing in the Catchment Area. A number of similar streams were present in that locality but this alga was not seen in any of them. Smith[2] writes "certain species of prasiola grow only where substrate is rich in nitrogen, as on rocks covered with the droppings of sea birds. Other species grow only in cold swiftly-flowing mountain streams". In this case neither of these conditions was fulfilled. The stream which supplied water to the filters of the Simla water-works was not flowing swiftly, and the rocks, part of which were projecting much above the water-level, were clean. It was, however, noticed that the thalli growing attached to the rocks in the middle of the stream were the largest and closely crowded while the plants attached to the rocks near the banks of the stream were smaller in size and fewer in number.

The largest expanded thallus measured 12.8 cm $\times$2. 4 cm.

A number of plants have been examined but reproductive structures have not been observed. A detailed study of the type will soon be undertaken and it may throw some light on the reproductive processes in this genus. The recent report by Yabe[3] regarding the occurrence of gametes of 2 sizes in P. japonica Yatabe and its criticism by Fritsch[1] together with the uncertain systematic position of this family clearly indicate the necessity of a proper investigation of this genus.

I am greatly indebted to the Secretary and the Health Officer, Municipal Committee, Simla for permitting me to visit the Catchment area, to Professor J.H. Mitter for providing the facility of going there and to Professor Fritsch for naming the species.

Department of Botany, R. N. Tandon.
University of Allahabad.

(1) F. E. Fritsch—*Structure and Reproduction of the Algae*, 1935.

(2) G. M. Smith—*The freshwater Algae of the United States*, 1935

(3) Y. Yabe—*'On the sexual reproduction of Prasiola japonica Yatabe.'*

Sci. Rep. Tokyo Bunrika Daigaku, 1, 39 - 40 - 1932 quoted from (1).

A Preliminary Note on the Floral Anatomy of some Ficoideae*

The floral anatomy of *Mollugo verticillata*, *M. hirta*, *M. spergula*, *Trianthema pentandra*, *T. monogyna* and *Gisekia pharmaceoides* has been studied, and the following results have been obtained.

A. *Receptacle:* In all the three *Mollugo* species and *Gisekia*, there is a complete vascular ring at the base of the receptacle. In *Trianthema monogyna*, although there is only a single ring of vascular tissue, the xylem is separated into numerous groups, but the phloem, even here, is continuous. In *T. pentandra* a complete vascular ring is formed only just before the perianth traces are given out.

B. *Perianth:* The vascular supply to the perianth in the three species of *Mollugo* is similar in all essentials. In. *M. verticillata*, ten traces are given out, of which five alternate ones go undivided to form the midribs of five perianth leaves, while each of the rest divides usually into two branches which go into adjacent perianth members to form the marginal bundles. In *Gisekia*, it is almost similar. In *Trianthema pentandra* numerous traces pass for the perianth tube, and each perianth member later gets an unequal number of bundles, ranging from 4 to 11. In *T. monogyna*, the supply is more complicated. A broad vascular commissure joining two opposite sides of the vascular ring traverses the pith. In its passage it forms a net-work of branches, and finally numerous small bundles are formed scattered within the pith. Some of these are the bundles of the perianth tube. The number of bundle received by the perianth members in *Trianthema* varies greatly. The difference in the vascular supply to the perianth in *Trianthema* and the rest of the species is explained by the difference in the conditions of the ovary.

* Part of the work submitted by the author for his M. Sc. degree in 1933, and was done under the guidance of Prof. A. C. Joshi, to whom the author's cordial thanks are due.

C. ***Androecium:*** In all the genera, every stamen receives a single trace. In ***M. Spergula,*** there are ten stamens and the vascular traces for them arise in two alternating sets of five which is worth noting. In. ***M. hirta,*** the staminal traces are fused for a short distance with the perianth traces, which indicates a remote relation with perigyny.

D. ***Gynoecium:*** In ***Gisekia pharnaceoides*** the pistil is apocarpous. From the axial vascular cylinder, a trace is given off for each ovary. This bears two lateral branches, and these three supply the ovary wall. After this, a bundle enters the ventral wall of every ovary, and this supplies the single ovule.

In ***Mollugo*** and ***Trianthema pentandra*** we meet with syncarpous ovaries, and their anatomy also resembles, and is comparable with, that of ***Gisekia.*** Each carpellary leaf in ***Mollugo*** receives a trace which bears two lateral branches.

The ovary of ***T. monogyna*** is unilocular and unicarpellary. The ovary wall receives an indefinite number of traces, with a large ventral trace which supplies the ovules. My observations of the anatomy of the gynoecium coincide with those made by Joshi[1] in his paper upon the stylar canal in Angiosperms.

Benares Hindu University,
Benares. V. S. Rao.
February, 1935.

1. *Ann. Bot.*, *48*, 1934.

On the Colouring Matters of *Oroxylum indicum*

From the bark of *Oroxylum indicum* Naylor and Chaplin[1] isolated a crystalline yellow substance, 'oroxylin', m.p. 228·5–229° and described its behaviour towards certain reagents. Later on a detailed examination of 'oroxylin' (m p. from 225°) was carried out by Naylor and Dyer[2] who assigned to it the formula $C_{19}H_{14}O_6$. It was found to give a triacetyl derivative on acetylation and a dibromo-compound on bromination. Hydrolysis with aqueous alkali of various concentrations was stated to give benzaldehyde, benzoic acid, phloroglucinol and phthalic acid. The latter was also obtained by permanganate oxidation of 'oroxylin'. It should be noted however that, with the exception of benzoic acid, none of the other degradation products were properly identified. We have established that Naylor and Dyer's 'oroxylin' is a mixture of at least three hydroxyflavones.

From an alcoholic extract of the bark of the above plant we have isolated, by a modification of Naylor and Dyer's method, crude flavones to the extent of 2·6%. From this we have been able to obtain so far three different fractions, A, B, and C.

Fraction A formed brown-yellow prisms and melted at 262—265°. This compound has been identified as baicalein[3].

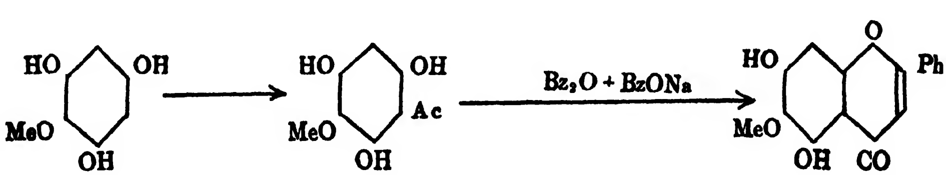
Fraction B (yellow needles from alcohol) had m.p. 229—31°. It dissolved in cold alkali or ammonia with a stable deep yellow colour and was indifferent towards chloropentamminecobalti chloride, showing the absence of –OH groups in the ortho- or para-positions to one another. Hydrolysis with alkali yielded acetophenone and benzoic acid. Demethylation gave baicalein (about 65%) and chrysin (about 35%). Fraction B is thus found to be a mixture of 6-methylbaicalein and chrysin. Analytical data of the sample are also in agreement with the above proportions of the flavones.

Fraction C (long yellow prisms) had m.p. 220–223°. Towards alkali and chloropentamminecobaltichloride it behaved in the same way as Fraction B. The analytical data were as follows: $C = 68.16, 68.2$; $H = 4.2, 3.96$; $OMe = 9.76\%$, and these differed slightly from the calculated values for 6-methylbaicalein. We are preparing larger quantities of this fraction with a view to purify it further.

Quite recently Shah, Mehta and Wheeler have reported the isolation of pure oroxylin, m. p. 231-32°, from the root bark of *Oroxylum indicum*, and have established that their oroxylin is 6-methylbaicalein. It may be noted however that the properties of pure oroxylin, as described by these authors, are not in entire agreement with those of our fractions, B and C. We however hope to compare our products with that of Shah *et al* as soon as we get a pure specimen of oroxylin. In the meantime attempts are being made to synthesize oroxylin (6-methylbaicalein) from iretol according to the scheme shown below.

In conclusion we offer our most sincere thanks to Messrs. Bengal Chemical & Pharmaceutical Works Ltd., Calcutta, for kindly supplying an alcoholic extract of the bark.

Chemistry Department,
University College of Science, P. K. Bose.
Calcutta. S. N. Bhattacharyya.
8. 2. 1936.



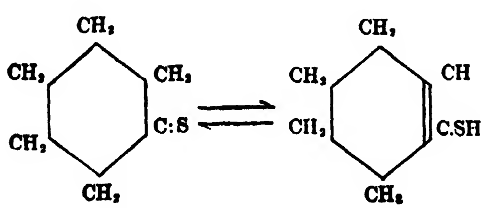
1 Naylor and Chaplin, *Pharm. J.*, *20*, 257, 1890—91.
2 Naylor and Dyer, *J. Chem. Soc.*, 954, 1901.
3 Shibata, Iwata and Nakamura, *Acta Phytochim.*, *1*, 105. 1923,
4 Shah, Mehta and Wheeler, *Curr. Sci.*, *4*, 406, 1935.

Synthesis of non-polymerized monocyclic Thioketones and their Derivatives.

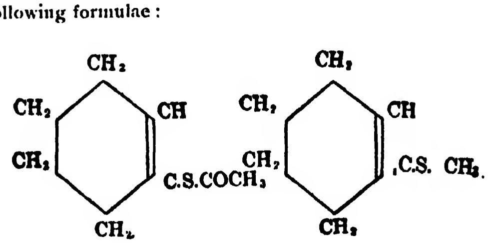
The various reactions of thiocamphor[1] led the author to the synthesis of non-polymerized monocyclic thioketones which are also expected to produce a number of interesting sulphur compounds. It has been possible to synthesize thiocyclohexanone, b. p. 75°/15 m. m., thiocyclopentanone, b. p. 86° - 88°/10 m. m., o-methyl thiocyclohexanone, b. p. 95°/10 m. m. and thiomenthone b. p, 215°-216°/763 m. m., by passing a simultaneous current of dry hydrochloric acid and sulphuretted hydrogen through a solution of the corresponding ketones in perfectly dry alcohol. Along with these products, trithiocyclohexanone, m. p. 101°, and trithiocyclopentanone, m. p. 99° have also been obtained identical with those of Fromm[2], who could isolate only these two trithio-derivatives by the action of successive currents of hydrochloric acid and sulphuretted hydrogen on cyclohexanone and cyclopentanone respectively in alcoholic solutions.

Thiomenthone appears to have been isolated by Speranski[3] by heating menthone with P_2S_5 to 140° only a very small amount of which is obtained along with a large quantity of menthene and Dimenthene-monosulphide. The monosulphide was also obtained by Fromm[4], who however could not obtain the non-polymerized derivative by the action of H_2S on menthone. But the present author obtained, by his general method[1], both thiomenthone (50%) and dimenthene-monosulphide (30%) from menthone.

These thioketones exhibit 'thio-thiol' tautomerism analogous to 'keto-enol' transformation and their formula is illustrated by the typical thioketone, thiocyclohexanone as shown below :

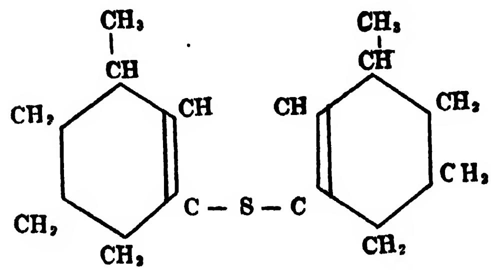


The pink colour of the freshly distilled thioketones is due to the presence of chromophoric C:S group, while the thioketones in the thiolic phase are colourless, which is justified by the isolation of colourless S-acetyl and S-methyl derivatives of the thioketones which are represented by the following formulae :



The above constitutional formulae have been proved correct by the easy removal of CH_3CO, and CH_3 groups by the action phenyl hydrazine, aniline, etc. even in cold. Acetyl thiocyclohexanone b. p. 85°/10 m. m. and acetyl thiocyclopentanone b. p. 67°/8 m. m. and acetyl thiomenthone, b. p. 120°-122°/10 m. m. and S-methyl thiocyclohexanone b. p. 55°/15 m. m. have been prepared. The acetyl derivatives with phenyl hydrazine in cold form acetyl phenyl hydrazine and phenyl hydrazones of corresponding thioketones with simultaneous evolution of H_2S while in the case of S-methyl thiocyclohexanone methyl mercaptan is evolved with formation of cyclohexanone phenyl hydrazone.

The ketonic behaviour of these thioketones is illustrated by their capacity to form phenyl hydrazones, semicarbazones and oximes identical with those of the corresponding ketones. The author suggests the following formula (*A*) for diemthene-monosulphide for which three constitutional formulae have been suggested by Speranski[3] and the question has been left unsettled by the latter author.



[A]

The detailed description of these investigations will be published in due course in the *Journal of the Indian Chemical Society*.

My sincere thanks are due to Sir P. C. Roy for his kind encouragements and also for the facilities of his laboratory.

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5.2.36

Dines Chandra Sen.

1. *Sen, J. Indian Chem. Soc.*, *12*, 647 ; 1935.
Ibid *12*, 751 ; 1935.
Sen, SCIENCE AND CULTURE, *1*, 159, 1935.
Ibid *1*, 435 ; 1935.
2. Fromm, *Ber. 60*, 2090, 1927.
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The Mineral and Protein Values of some Indian Foodstuffs

The researches of Guha and co-workers[1] indicate the urgency of obtaining information about the content of the physiologically important elements, like calcium, iron and phosphorus, in common Indian foodstuffs. It has been suspected that the average dietary of the urban population in Bengal, apart from being partially deficient in certain vitamins and in proteins of high biological value, also lacks the aforesaid important minerals to some extent. This latter aspect of the nutritional question, as Guha[1] points out, has not apparently received the attention it deserves and has undoubtedly much to do with the pre and post-natal ill-health so common in Bengali women and also with the ill health of the new born. This is particularly so with reference to iron. In this note in continuation of the work of Guha, we are giving the values for protein, calcium, iron and phosphorus of a number of common Indian foodstuffs in the table given below:

Serial No.	Bengali Names.	English Names.	Botanical Names.	Percentage in the edible portions of fresh foodstuffs			
				Fe	Ca	P_2O_5	Protein
1.	Ful-kopi	Cauli-flower	Brassica oleracea, var. Botrytis	0.0011	0.054	0.150	2.42
2.	Mula	Radish	Raphanus sativus	0.0018	0.055	0.059	0.69
3.	Shalgom	Turnip	Brassica campestris, Var.	0.0009	0.075	0.065	0.62
4.	Jhinge	Sponge gourd	Luffa acutangula	0.0008	0.024	0.646	0.19
5.	Sasa	Cucumber	Cucumis ratisin	0.0006	0.029	0.252	0.34
6.	Kakor	—	Momordica dioica	0.0011	0.043	0.427	1.02
7.	Uchchhe	Bitter gourd (small)	Momordica muricata	0.0034	0.037	1.336	1.11
8.	Karalla	Bitter gourd (large)	Momordica Charantia	0.0019	0.033	1.725	1.06
9.	Matorshuti	Peas (Green)	Pisum sativum	0.0026	0.036	0.224	6.42
10.	Begun	Egg fruit	Solanum melongena	0.0006	0.020	0.776	1.27
11.	Pepe	Papaw	Carica papaya	0.0013	0.135	1.290	1.02
12.	Amrah	—	Spondias mangifera	0.0016	0.142	0.784	0.49
13.	Dhenki-shak	Fern	Nephrodium mollich	0.0026	0.033	0.476	2.26
14.	Data	—	Amarantus gangeticus	0.0013	0.404	0.197	0.73
15	Chhim	Bengali bean	Dolichoslablab	0.0017	0.085	0.162	2.67
16.	French bean	French bean	Phaseolus vulgaris	0.0013	0.053	0.563	1.78
17.	Mocha	Plantain flower	Spike of musa sapientum	0.0013	0.032	1.605	1.93
18.	Gole-aloo	Potato	Solanum tuberosum	0.0011	0.016	0.148	0.89
19.	Squash	Squash	Cucurbita sp.	0.0013	0.009	0.037	0.62
20.	Gajar	Carrot	Daucus carota	0.0072	0.049	0.208	0.65
21.	Barbati	String bean	Vigna catjang	0.0011	0.060	0.199	3.64
22.	Mishti-kumro	Sweet gourd	Cucurbita maxima	0.0012	0.059	0.096	0.95
23.	Chal-kumro	White gourd	Be nincasacriapra	0.0007	0.045	0.654	0.33
24.	Mishti-aloo	Sweet potato	Ipomoea patatas	0.0055	0.012	0.168	1.03

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7.2.1936

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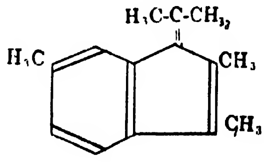
1. Guha, *Jour. Ind. Med. Ass.*, 4, 485, 1935.

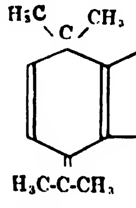
Synthetic Study on the Structure of Azulene

Two structural formulae have been suggested for the blue pigment which is associated with the high boiling fractions of certain volatile oils, (I) by Kremer[1] and (II) by Ruzicka and Haagen-smit[2] as explaining many known facts concerning the substance.

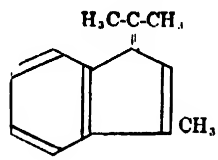
The hydrocarbon III having a structure and arrangement of double bonds similar to that in Kremer's formula has been prepared according to the following scheme.



I



II



III

Ethyl Δ^1-tetrahydrobenzoate is condensed with ethyl sodiocyanoacetate, and the resulting sodio-derivative is allowed to react with ethyl bromoacetate when ethyl 1-carbethoxy cyclohexane -2-α-cyanosuccinate (b. p. 204°-206°/4 mm) is obtained. This on hydrolysis gives 1-carboxy cyclohexane 2 succinic acid (gummy). The ethyl ester (b. p. 177°-185°/7mm) of the above acid is cyclized with granulated sodium to yield (0:3:4 bicyclo) nonan 2-one-3:4-dicarboxylate. (b. p. 188/8mm.) This on hydrolysis gives the required keto-acid (m.p. 136°. Semicarbazone m. p. 220°C). The corresponding keto-ester (b. p. 143°-144/8mm Semicarbazone. m. p. 159°C) is treated with methylmagnesium iodide to yield a neutral product (154°/4 mm) which on dehydrogenation with selenium furnishes III (m. p. 51° yellow needles).

Experiments on similar lines are in progress for the synthesis of the compound I given above.

The details of the above work will be published in the *Journal of the Indian Chemical Society*.

My sincere thanks are due to Professor Dr. P. C. Mitter for much encouragement and advice during the course of this work.

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11.2.36.

1. *J. Amer. Chem. Soc.* 717, 1923.
2. *Helv. Chim. Acta*, *14*, 1194.

Pressure-Effect of Electrical Resistance of Metal at Low Temperatures

The effect of pressure on the electrical resistance of a large number of metals has been experimentally investigated by U. Fisher[1], and more extensively by P. W. Bridgman[2], at the temperature of solid carbon dioxide (–78° C) and of liquid oxygen (–183° C). They observe that with a very few exceptions (notably Pb), the pressure-coefficient of electrical resistance at very low temperature is in general numerically greater than that at 0°C, for all orientations of the metal crystal. In a detailed paper to appear shortly elsewhere, the pressure-coefficient at low temperature has been calculated by the present author on Bloch's deformable ionic model of metal crystal. The purpose of the present note is to indicate briefly the outline of the method of calculation used and to report the results obtained which appear to be of some interest in the light of the observations made by Bridgman.

Calculations: The specific electrical resistance[3] of metals on Bloch's model at low temperatures is given by

$$\rho = B \cdot \frac{T^5}{\theta^6} J_5\left(\frac{\theta}{T}\right), \tag{1}$$

where B is a factor depending on the number of free electrons in the metal and a ratio of other quantities which may be taken as independent of pressure, T = the absolute temperature, θ = the Debye temperature of the metal, and J_5 stands for the integral

$$J_5 = \int_0^{\theta/T} \frac{x^5\,dx}{(e^x - 1)(1 - e^{-x})} \tag{2}$$

The pressure-coefficient of specific resistance at constant temperature can therefore be expressed as

$$\frac{1}{\rho}\left(\frac{d\rho}{dp}\right)_T = \left(\frac{\delta \log B}{\delta p}\right)_T - \frac{6}{\theta}\left(\frac{\delta \theta}{\delta p}\right)_T + \left(\frac{\delta \log J}{\delta p}\right)_T \tag{3}$$

$$\text{Also} \left(\frac{\delta \log J}{\delta p}\right)_T = \left(\frac{\delta \log J}{\delta \log \theta}\right)_T \left(\frac{\delta \log \theta}{\delta p}\right)_T$$

$$= \frac{\theta/T}{J}\,\frac{dJ}{d(\theta/T)}\,\frac{1}{\theta}\left(\frac{\delta\theta}{\delta p}\right)_T \tag{4}$$

The change of electrical resistance with increase of pressure is therefore contributed by two causes: (1) a change in the Debye-frequency of metal; the Debye-frequency increases with increase of pressure causing a decrease of resistance of the metal, and (2) a change in the effective

number of conductivity electrons in the metal, which decreases with increase of pressure causing an increase of the resistance. The two effects are thus mutually opposite to each other, but the contribution from (1) is far greater than that from (2), and in fact, as will be shown below, (1) explains fairly well the pressure coefficients in the majority of the cases observed. Neglecting therefore for the present the first factor in (3), we obtain from (3) and (4)

$$\left[\frac{1}{\varrho}\left(\frac{d\varrho}{dp}\right)_T\right]_{\theta,J} = \frac{1}{\theta}\left(\frac{\delta\theta}{\delta p}\right)_T \times \left[6 - \frac{x_0}{J}\,\frac{dJ_5}{dx_0}\right]. \tag{5}$$

where $x_0 = \theta/T$, the upper limit of integration in (2). Now the term within the square bracket can be evaluated with the help of the transformation

$$J_5 = \int_0^{\theta/T}\frac{x^5\,dx}{(e^x-1)(1-e^{-x})} = 5\int_0^{\theta/T}\frac{x^4\,dx}{e^x-1} - \left|\frac{x^5}{e^x-1}\right|_0^{\theta/T},$$

and using the expansion (for x_0 lying between 0 to 2)

$$\int_0^{x_0}\frac{x^4}{e^x-1}\,dx = \frac{x_0^4}{4} - \frac{x_0^5}{10} + \frac{x_0^6}{72} - \frac{x_0^8}{5760} + \frac{x_0^{10}}{302400} - \dots\dots \tag{6}$$

and for higher values of x_0 (between 2 to ∞)

$$\int_{x_0}^{\infty}\frac{x^4\,dx}{e^x-1} = \sum_{n=1}^{\infty} e^{-nx_0}\left(\frac{x_0^4}{n} + \frac{4x_0^3}{n^2} + \frac{12x_0^2}{n^3} + \frac{24x_0}{n^4} + \frac{24}{n^5}\right), \tag{7}$$

the last integral between the limits 0 to ∞ being equal to 24·88. The factor dJ_5/dx_0 is simply the integrand of (2).

Now to calculate the factor $\frac{1}{\theta}\frac{\delta\theta}{\delta p}$, we proceed to a rigorous quantum theoretical generalization of a thermodynamical method first introduced by Gruneisen[4]. The total free energy of a system of oscillators forming the crystal-lattice of a metal (considering Debye's model of elastic continuum) is given by

$$F = \Phi_0 + kT\sum_{\nu} F\left(\frac{h\nu}{kT}\right),\ \Phi_0 = \text{null-point energy.}$$

$$= \Phi_0 + 3RT\left\{F\left(\frac{\theta}{T}\right) - \tfrac{1}{3}D\left(\frac{\theta}{T}\right)\right\} \tag{8}$$

where

$$F(x) = \ln\left(1-e^{-x}\right),\quad D(x) = \frac{3}{x_0^3}\int_0^{x_0}\frac{\xi^3}{e^{\xi}-1}\,d\xi \tag{9}$$

Now expanding the functions $F(x)$ and $D(x)$ for the low temperature approximation (x_0 between 2 to ∞), and differentiating these with respect to T, we obtain after a little calculation, the entropy of the system

$$S = -\frac{\delta F}{\delta T} = 3R\left\{\frac{4\pi^4}{15x_0^3} - \sum_{n=1}^{\infty} e^{-nx_0}\left[x_0 + \frac{1}{n} + \frac{12}{n^2}\frac{1}{x_0} + \frac{24}{n^3}\frac{1}{x_0^2} + \frac{24}{n^4}\frac{1}{x_0^3}\right] - \ln\left(1-e^{-x_0}\right) + \frac{x_0}{e^{x_0}-1}\right\} \tag{10}$$

Differentiating (10) with respect to pressure p, and using the wellknown thermodynamical relation

$$\left(\frac{\delta s}{\delta p}\right)_T = -\left(\frac{\delta V}{\delta T}\right)_p \tag{11}$$

we obtain the pressure-variation of Debye-temperature

$$\frac{1}{\theta}\left(\frac{\delta\theta}{\delta p}\right)_T = \frac{\beta}{c_m d}\,\frac{1}{f_2(x_0)} \tag{12}$$

where $\beta = \frac{1}{V}\frac{\delta V}{\delta T}$, the coefficient of thermal expansion, c_m the specific heat per gramme, and d = the density of the metal. Here $f_2(x_0)$ stands for the function

$$f_2(x_0) = x_0^2\left[\frac{4\pi^4}{5x_0^5} + \frac{e^{x_0}}{(e^{x_0}-1)^2} - \sum_{n=1}^{\infty} e^{-nx_0}\left\{n + \frac{3}{x_0} + \frac{12}{n}\frac{1}{x_0^2} + \frac{36}{n^2}\frac{1}{x_0^3} + \frac{72}{n^3}\frac{1}{x_0^4} + \frac{72}{n^4}\frac{1}{x_0^5}\right\}\right] \tag{13}$$

Combining (12) with (5) we obtain immediately

$$\frac{1}{\varrho}\left(\frac{d\varrho}{dp}\right)_T = \frac{\beta}{c_m d}\left[6 - \frac{x_0}{J_5}\frac{dJ_5}{dx_0}\right]\frac{1}{f_2(x_0)} \tag{14}$$

Evaluation of the integral J_5 and its variation with x_0 shows that the factor within the square bracket of (14) lies between 2 to 6 for all values of x_0. The function $f_2(x_0)$ is also less than 1 at low temperatures. Equation (14) therefore shows that the pressure-coefficient at low temperatures is in general very much greater than $\beta/c_m d$, which represents the order of magnitude of the coefficient at 0°C.

Discussions. The pressure coefficient of resistance of a number of metals at −185°C, calculated according to (14), are shown in the following table. The average pressure-coefficients of these metals at this temperature up to a pressure-range of 7000 kg/cm² have been observed by Bridgman[1] and are shown in the same table. A comparison between the observed and the calculated value sshows that except for

Li, which always behaves anomalously, the agreement is as satisfactory as can be expected.

The pressure-coefficients at 0°C on Bloch's model can also be calculated proceeding on exactly the same lines only different approximations for $F(x)$ and $D(x)$, and the integral in (6) should be used. We omit the details of such calculations, but quote only the results in the last column. It will be noticed that *almost in all cases the coefficient at −183°C comes out to be numerically greater than that at 0°C.*

The numerical values of the coefficients in both the cases are, however, in general seen to be slightly higher than the observed values. This difference may be ascribed to the effect of decrease in the effective number of conductivity electrons with pressure.

It is particularly interesting to point out that in the case of Pb, Bridgman has observed that the numerical value of the coefficient slightly diminishes at low temperatures compared to that at 0°C. The calculated results for Pb also show the same peculiarity.

TABLE I.

Pressure-coefficient of resistance of metals.

Element	θ	$\frac{x_0}{J}\frac{dJ_5}{dx_0}$	$f_2(x_0)$	$\frac{\beta}{c_m d}\cdot 10^{12}$	$-\frac{1}{\varrho}\frac{d\varrho}{dp}$ at −183°C		$-\frac{1}{\varrho}\frac{d\varrho}{dp}$ at 0°C	
					calc.	obs.	calc.	obs.
Li	510	1·79	0·2958	9·281	—	-	22·13	—7·12
Na	202	3·49	·6776	17·50	64·86	—	41·59	51·9
K	126	3·72	·9095	45·18	113·2	—	90·84	66·3
Au	175	3·61	·8289	1·338	3·86	3·27	3·436	2·94
Ag	215	3·43	·7278	1·528	5·39	4·09	4·786	3·45
Cu	310	2·94	·5794	·764	4·036	3·09	3·251	1·88
Al	396	2·45	·4416	1·364	10·96	9·16	7·943	4·28
Ni	375	2·59	4808	·7852	5·585	1·88 ?	2·213	1·85
Pb	90	3·8	·9520	5·105	11·83	12·76	12·71	12·99
Pd	(230)	3·35	·7395	1·106	3·96	2·82	2·518	2·13
Pt	225	3·38	·7362	·6622	2·36	2·34	1·932	1·93
Mo	379	2·56	·460	·5296	3·97	1·91	1·458	1·30

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15. 1. 36.

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2. P. W. Bridgman, *Proc. Amer. Acad.* *67*/8, 305, 1932.
3. H. Bethe, ***Handbuch der Physik, 24/2***, p. 529.
4. E. Grüneisen, ***Handbuch der Physik, 10***, 28, 1928

On the Raman Spectrum of Solid Carbon Disulphide

The Raman spectrum of solid carbon disulphide at the temperature of liquid air has been experimentally investigated. The spectrogram is reproduced in Fig. 1 (a), and that due to liquid carbon disulphide at the room temperature is reproduced in Fig. 1 (b) for comparison. Two important facts are observed from the comparison of the two spectrograms. In the case of solid carbon disulphide at the temperature of the liquid air, there is a sharp and intense new Raman line at 69 cm^{-1} with a faint and sharp satellite at 80 cm^{-1}. Secondly, the satellite 648 cm^{-1} of the principal Raman line 656 cm^{-1} is absent in the case of the solid, and also the line 656 cm^{-1} is very sharp in this case.

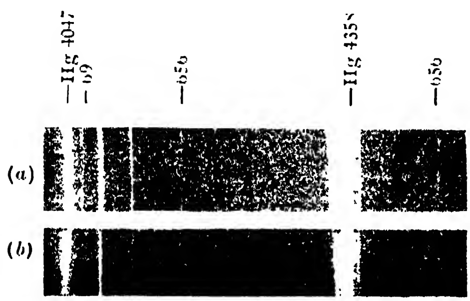

FIG. 1

The absence of the satellite 648 cm^{-1} at the low temperature is in confirmation of the theoretical interpretation regarding the origin of the line given by Placzek[1]. Applying in this case the hypothesis that there is displacement of the terms and mixing up of the "proper functions" when the terms are so close together that the distance between them is of the order of magnitude of the coupling energy, which Fermi first applied to explain the term scheme of carbon dioxide. Placzek has shown that the satellite 648 cm^{-1} is due to the transition from the state 01_1 to the state 03_1 of the carbon disulphide molecule. The intensity of the satellite should, according to this hypothesis, depend on the population of the initial state 01_1. Since the energy value of this state, according to Placzek, is about 390 cm^{-1}, the percentage of the molecules at this state is appreciable at the room temperature. At the temperature of liquid air, however, this percentage is negligible and therefore the satellite vanishes.

As regards the origin of the new Raman line 69 cm^{-1} and its satellite 80 cm^{-1} observed in the case of the solid carbon disulphide, it appears from the large intensity of the former line and from the sharpness of both the lines that they are probably not due to lattice oscillation but may be due to the oscillations of some complex polymerized molecule as has been suggested in the case of naphthalene by the present author[2]. Since the "wing" accompanying the Rayleigh line observed in the case of liquid carbon disulphide at the room temperature extends only up to about 40 cm^{-1}, its intense portion being very near the Rayleigh line, it appears that the line 69 cm^{-1} observed in the case of the solid has no connection with the "wing".

Investigations of the Raman spectra of other similar and simple substances at the temperature of liquid air are in progress and these results will be discussed in a paper which will be published shortly in the *Indian Journal of Physics*.

The author's thanks are due to Prof. D. M. B[illegible] for his kind interest in the work.

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17. 2. 1936.

1. For a full discussion see *Handbuch der Radiologie*, Vol. 6, Part II, p. 316, 1934.
2. Sirkar, S. C., *Ind. Jour. Phys*, 10 Part II, (in the press).

On Paramagnetism Independent of Temperature

The problem of the origin of constant paramagnetism in substances like $KMnO_4$, $K_2Cr_2O_7$, V_2O_5 etc. has uptil now received no satisfactory solution at the hands of physicists, and probably, such solution will not be forthcoming before we get a thorough knowledge of the energy states of such polyatomic molecules. It has been suggested by some that this constant paramagnetism has its origin in the high frequency elements of the moment matrix, while others maintain that it is due to a polarization of the magnetogenetic atom. When a quantitative theory is worked out it may appear that there is no fundamental difference between the two interpretations. In the mean time more detailed investigations on the substances may help to throw light on the solution of the problem.

With this end in view we have undertaken a study of the thermo magnetic properties of substances which belong to this class of compounds. Our study reveals that:

(1) The atomic susceptibility (χ_A) of the magnetogenetic atom is not a constant. It appears generally that χ_A is lower for more energetic bindings and higher for the weaker ones.

(2) χ_A depends on the interatomic field as is illustrated by the difference in values of χ_A for the amorphous and crystalline varieties of V_2O_5

Amorphous	V_2O_5,	$\chi_A = 39{\cdot}5 . 10^{-6}$
Crystalline	V_2O_5,	$\chi_A = 37{\cdot}6 . 10^{-6}$

(3) In the iron family of elements the saturated oxides or their salts give χ_A values which gradually increase with

increase in the atomic number (Z), or the number of electrons (N) in the 3d shell. This relation between χ_A and Z or N for elements Sc (21) to Mn (25) may be compared with the relation between the apparent Bohr magneton number (μ_B) for only spin values and N. This is shown in the table below.

TABLE I.

Element	Z	N	$\chi_A .10^6$	Ion	N	μ_B
Sc	21	1	.57	Sc^3, Ti^3, V^4	1	1.73
Ti	22	2	1.45	Ti^2, V^3	2	2.83
V	23	3	3.95	V^2, Cr^3, Mn^4	3	3.87
Cr	24	4	4.73	Cr^2, Mn^3	4	4.90
Mn	25	5	5.80	Mn^2, Fe^3	5	5.92

(The above values of χ_A are not corrected for the diamagnetism of the atom itself.)

This dependence of χ_A on N in a manner analogous to that of μ_B on N leads one to believe that both χ_A and μ^B have a related origin.

(4) The thermal behaviour shows that the observed paramagnetic susceptibility generally decreases slightly with temperature, and has a mean negative thermal coefficient $5-8.10^{-6}$ for TiO_2 & V_2O_4 between 25°C and 500°C, though the rate of change is not uniform. $K_2Cr_2O_7$ has, however, a larger coefficient of opposite sign 6.10^{-4} between room temperature and its melting point (396°C). The susceptibility increases with temperature upto about 260°C, when there is a slight drop, beyond which it again rises till it encounters a drop again at the melting point. Beyond this there is again a rise. The first drop at 260°C may be associated with the change, at about that temperature, of the material from the α to the β variety.

Compounds like $K_4Fe(CN)_6$, K_2TiF_6, which are diamagnetic, show an increase in diamagnetism, and hence a decrease with temperature in the so-called constant paramagnetism of the atom.

A detailed paper is soon to appear in the *Indian Journal of Physics.*

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The Pre-Aryan Origin of S'iva

It has been suspected that the origin of the S'iva cult and the phallic worship must be ascribed to the non-Aryans. But so long there was no proof to lend force to this conjecture. Indeed, Hopkins pointed out that phallic worship is not a special feature of the present aboriginal tribes of India.

The discoveries at Mohenjo-daro have definitely proved the existence of S'iva and phallic worship among the authors of the Indus Civilization. Of several seals depicting the god, the most important one represents S'iva as Yogindra and Pas'upati. The figure has also got a trident, or more probably, horns over its head, sharing this characteristic with the ancient divine and royal figures of the Near East. Dr. Mackay in his excellent monograph on the Indus Civilization says that the horned deity was introduced in India by the Indus Valley people and disappeared again with them. This, however, is not a fact. The horns recur in some South—Indian images of S'iva produced during the Pallava rule. The horn and the crescent moon aer mutually connected in other countries, and it is therefore in the horns of the Mohenjo-daro S'iva that we must seek the origin of the *candra-kala* decorating the head of the classical S'iva.

The above Mohenjo-daro seal almost certainly depicts S'iva as *urdhvalinga*. Though this is a traditional characteristic of S'iva, an examination of the *S'ilpas'astras* shows that the texts do not lay this down as a compulsory trait of the god. Turning to archaeological evidence we find that all the S'iva images of Bengal have this characteristic, and that it is only sporadically and rarely found in other provinces, the Lakulis'a images excepted.

These are several ways in which the identification of the Vedic Rudra and the Mohenjo-daro prototype of S'iva might have taken place. The thunder-bolt is regarded as a piece of stone all over the Old World. It may be the similarity of the thunder stone (the weapon of Rudra) and the phallic-stone (the emblem of S'iva) that may have led to the identification. Again, both the gods were *pas'upatis* and the Mohenjo-daro god might have been regarded as red and lustrous like the Vedic Rudra.

A detailed treatment of the subject will appear in *Indian Culture*

Allahabad
26. 1. 1936

Amalananda Ghosh.

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Representation of Mysore in the Council of the Indian Institute of Science, Bangalore

According to the present regulations, the Government of His Highness the Maharajah of Mysore nominates two representatives to the Council. In addition to that, the Mysore University is a member of the constituency of the South-Indian universities (Andhra, Madras, Annamalai, and Hyderabad), and there is thus the chance of a third Mysorean being elected to the council. (As a matter of fact for the last two occasions, a representative of the University of Mysore is being elected by the South-Indian constituency to the Council. This gives over-representation to Mysore, particularly as the present Director has, as our information goes, identified himself almost completely with the interests of Mysore. Our information is that this solid Mysorean block of four always votes *en bloc*, and in many important matters, particularly concerning appointment, they were able to carry their own points. This is not desirable as the Institute is an All-India body, and equal chances should be given to people from all parts of India. We might mention that we are not alone in our opposition to the over-representation of Mysore. The special committee of 1921 remarked (p. 11): "It will be noted that the Central Government and the Government of His Highness the Maharajah of Mysore would, under this scheme, each appoint two nominees; it may be expected that one of the latter two would be a nominee of the University of Mysore, and for that reason, no further representation of this (Mysore) University is suggested."

We are entirely in agreement with this view, and hope that the present Reviewing Committee would carefully consider this point.

K. K. L.

Effective Oral Therapy in Diabetics Mellitus

Since a long time, it was vaguely known to the physiologists that pancreas was somehow intimately associated with the metabolism of carbohydrates. But in 1889 Von Mering and Minkowski demonstrated that animals whose pancreas has been removed, showed symptoms almost exactly like those of human subjects suffering from Diabetes Mellitus. Later on, it was found out, through further work, that certain specialised cells in the pancreas called 'islands of Langerhans' were chiefly concerned with carbohydrate metabolism.

Numerous futile attempts have since been made to isolate an extract from the pancreas which might prove of use in this metabolic disorder. In 1920 Banting prepared an extract of the 'islands of Langerhans' free from the acinar elements of the pancreas and with this he succeeded in keeping depancreatised (without a pancreas) dogs alive and well. Later on, in 1921-22 he and his colleagues at the University of Toronto, successfully prepared an alcoholic extract of the above mentioned specialised structure of the pancreas ('islands of Langerhans') with the same properties and found that it reduced the blood sugar in a diabetic boy.

Though not yet exactly worked out in the pure form, Abel succeeded in extracting out a crystalline product for which he suggested a probable formula $C_{45}\ H_{69}\ O_{11}\ N_{11}\ S.3\ H_2 0$. This substance which is Insulin in a more or less pure form, is protein like in nature. It is stable in solutions of pH_4 to pH_7, beyond these limits it appears to be destroyed.

Now, it appears primarily, that the action of Insulin is not so much to change the tissues so that they can utilise the dextrose but to change dextrose so that the tissues of a diabetic can use it to his advantage. In diabetes the insufficient natural supply of Insulin from the changed 'islands of Langerhans' is replenished when proper doses of Insulin are given by injection. Thus by preventing the damaged islands from being drawn up to exert their utmost degree and thus get fatigued unduly, the injected Insulin may also suitably serve by bringing about a rest of those glands presiding over the metabolism of carbohydrates. According to some this rest to the 'islands of Langerhans' afforded by the injection of Insulin might improve their natural power to produce, later on, its own Insulin. Indirectly, as the satisfactory combustion of dextrose appears essential for the proper utilisation and burning of the accumulation of the ketone (Diasectic Acid, Acetone etc.) bodies in the system, and consequently prevent diabetic ketosis and coma.

In the diabetic subject, the injection of Insulin is followed by a rapid fall in the sugar of the blood, the disappearance of the glucose and acetone bodies from the urine and a general all-round improvement is noticed in the patient. There is an increase in the body weight and also in physical strength. The polyuria lessens, the thrist diminishes, and the nutrition of the skin and hair etc. also improve. The patient who was gloomy and dejected before treatment feels more cheerful, alert, and hopeful.

But, under all circumstances Insulin has got to be given by injection and that every few hours, because after a dose of Insulin, it is utilised by the tissues, and then the symptoms of Diabetes slowly return. Hence, in order to maintain, the normal conditions a new injection is necessary at least twice daily if not every few hours.

In the domain of surgery, in the diabetic subject, and in the treatment of complications of Diabetes which are varied and numerous, the injections of Insulin have proved of inestimable value. Formerly in pre-insulin days these conditions used to prove invariably fatal. But, now-a-days timely administration of Insulin saves most of them.

Numerous fruitless efforts were made in various parts of the world to prepare an effective Insulin preparation which could control Diabetes when exihibited orally. Insulin in these solutions is precipitated and rendered mostly inactive when in alkaline and acid medium. Given orally, Insulin is rendered inactive by the trypsin and is destroyed by the acid of the gastric juice. But the phosphotungstate of Insulin sold under the commercial name of "ORALIN" has been found quite effective in oral administration and acts exactly like Insulin given by injection as will appear from the following, quoted from the ***British Medical Journal***, No. 3649, Sat. 13-12-30, pp. 1002-1003.

"At a meeting of the Section of Surgery of Royal Society of Medicine on December 3rd. with Mr. C. H. Fagge in the chair, Professor G. E. Gask opened a discussion on Surgery in Diabetes.

* * * *

Dr. O. Leyton mentioned the recent experiments of Harendra Nath Mukherjee, who had found it possible to produce hypoglychaemia with Phosphotungstate of Insulin given by mouth, and whose results he had been able to confirm at the London Hospital.

In Surgical cases where injections were resented by the patient, this might offer a good method of controlling Diabetes......"